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AFTER GRADUATION—WHAT THEN?

By H. P. HAMMOND

President of the Society

A principle on which there seems to be universal agreement is that it is not the aim of the undergraduate curriculum to produce "finished" engineers—men capable of engaging in responsible professional practice. It follows, therefore, since the profession is concerned in the eventual development of men capable of such practice, that consideration—very careful consideration—should be given to that phase of engineering education, and of professional development, which follows the stage marked by the award of the bachelor's degree. This seems so obvious as scarcely to need statement, yet it is a matter to which very little constructive effort has been devoted and to which, until now, none has been directed by the profession as a whole.

Some four-year graduates will and should remain in college for more extended training. At present about one-sixth of those holding the bachelor's degree continue their work for a fifth year and secure the master's degree, and a smaller, but increasing, proportion go on to the doctorate. This is as it should be; the engineering college, while not the only place, is doubtless the best place, generally speaking, in which programs of advanced study and research can be conducted. For the bulk of our graduates, however, the formal part of their engineering education stops at the end of the four collegiate years, whether or not this is best is not the question now under consideration; even, however, if the program of collegiate engineering education were extended to five years, or to six, the fundamental question of the post-scholastic engineering education and the professional development of the young engineer would remain, demanding consideration of those interested in the welfare of the profession.

What are the elements of this problem and how may it be approached? It may be worth while to summarize some of them even though they are already well and widely known:

There is, of course, the problem of fitting the man to the job, or the job to the man (happily there are now jobs to which men can be fitted). This phase of the problem is of concern to every administrative and personnel officer. Real progress has been made in connection with it in recent years. A committee of the Society

under the chairmanship of Professor Bangs, of Cornell, has as its particular duty continued study of this matter.

There is also the problem of giving the graduate—or the about-to-be graduated student—some comprehensive knowledge of the profession he is about to enter—of its professional organizations, of the opportunities it offers and the responsibilities it involves, and of its ideals and ethical standards. Some progress has been made in connection with this phase of the general problem, but apparently less than its importance deserves. Both the schools and the profession have a direct responsibility in relation to it.

Every graduate who plans to follow engineering practice as a career should affiliate himself with the appropriate national societies and local groups of engineers and thereby identify himself as a member of the profession he is joining. While this may be considered as chiefly the concern of the engineering societies it is one toward which the engineering schools should feel a sense of responsibility.

Then there is the matter of the continuation of the education of the young engineer, and this is the chief problem to which these remarks are addressed. Heretofore our profession has done, or perhaps it might be fairer to say has been able to do, very little in this connection. In some urban centers an increasing number of graduates are availing themselves of opportunities for post-graduate instruction offered in evening hours by colleges of the vicinity. In some industries, but almost exclusively in the largest, training programs are provided which range from regular study of a post-graduate nature to planned sequences of experience in various departments of the company. But on the whole there is little or nothing in our profession that serves the purpose of the period of systematic apprenticeship which the medical graduate experiences during his interneship. Up to the present time no means have been available of assisting or of guiding the graduate who feels the need systematically to continue his education through self-directed study. No greater need or, opportunity exists for the engineering profession today than in this respect.

And finally there is the matter of informing the graduate of the requirements and procedures of the registration laws in the several states. The college and the profession jointly have an important responsibility in this connection.

Until the present time the various aspects of the induction of the graduate into his career and of his professional development and advancement have been dealt with only sporadically; the profession as a whole has not united in considering the matter or in providing means for dealing with it. The reason for this has been chiefly that no agency has existed through which a common program

of effort could be undertaken. Now, happily, that lack no longer exists. The Engineers' Council for Professional Development, upon which the interest of the colleges has centered recently in connection with the accrediting program, has the broader purpose indicated by its title—*professional development*. Accrediting of schools, though a vital matter, is but one phase of the broader program which the Council has undertaken. Matters relating to the personal and professional growth and development of the graduate as an engineer and a citizen are being dealt with by one of the Council's Committees, that on professional training. It was the inauguration of the program planned by this committee on which Past-President Rees was actively engaged at the time of his death. Mr. O. W. Eshbach is now serving as the chairman of this committee, which is continuing the work along the same lines as those originally laid out. The work of this committee is of vital importance to the entire profession. It deserves to be supported and assisted by the members of our Society as need and opportunity arise.

ARE WE GRADUATING TOO MANY ENGINEERS?*

By WILLIAM OTIS HOTCHKISS

President, Rensselaer Polytechnic Institute

If we in the engineering schools will but give adequate emphasis to the importance of acquiring the qualities that make up character and personality—the qualities so necessary for the leadership our times are crying for today—then I think we may most emphatically answer in the negative the question, "Are we graduating too many engineers?"

We have a great service to perform in producing the kind of leaders that the future will not find in sufficient numbers even with our best efforts—men of high character and fine personality who are trained in the scientific method of attack on whatever problems may be theirs to solve.

The teachers of cultural courses have too generally over-emphasized the importance of the strictly cultural; but the teachers of science and engineering have in their turn too generally overemphasized the importance of the strictly technical. We have over-stressed these things, or allowed our students to do so, and have not attached sufficient importance to the cultural phases of education.

But worse still, in both types of courses, is our failure sufficiently to impress our students with the importance of character and personality and the ways in which these must be cultivated. We have been doing a good job in scientific training in the technical schools; but we need now to consider the ways in which character and personality are built up and see that these are added to the qualities of our graduates.

Comparing cultural courses with scientific courses "as a preparation for living," Dr. Hotchkiss said:

I am convinced that the graduate with the mental habit of the quantitative approach to whatever problem may confront him is better prepared than the one whose college training has given him the habit of qualitative approach. In the study of history, economics, languages and literature, the habits of thought are all of one kind. For a given historical or economic fact there are certain recognizable causes. One scholar may give one cause as para-

* Abstract of address made before alumni in New York City, January 30, 1937.

mount. A second scholar may say the first is wrong, that the prime cause is something else. It is difficult and often impossible to find rigid proof of which is right. There is little possibility of such a thing as quantitative evaluation of the factors involved, and so the approach to any problem in history or economics must be largely qualitative.

In the study of languages and literature the situation is the same. One authority may say that one piece of writing is better than another. Another authority may hold the opposite. There are no possible criteria by which one may say that a given literary result is 92 per cent perfect and another is 53 per cent perfect when we are comparing the work of various authors. Again, the only method of thinking which the student can acquire in such courses is qualitative. He does not acquire the habit of evaluating the factors in a matter that is before him for consideration, because in his courses no exact evaluation is possible.

The courses in engineering and science, on the other hand, are characterized all through by the definite quantitative nature of thought that they require. You cannot consider a chemical formula or a law of physics or mathematics as a subject about which reputable authorities can take diametrically opposite points of view as they may in history or economics or literature.

I shall detain you no longer in the demonstration of what we should not do, but straight conduct ye to a hillside, where I will point ye out the right path of a virtuous and noble education; laborious indeed at the first ascent, but else so smooth, so green, so full of goodly prospect and melodious sounds on every side that the harp of Orpheus was not more charming.

JOHN MILTON

PART-TIME COURSES FOR GRADUATE ENGINEERS IN CHICAGO

By H. T. HEALD

Dean, Armour Institute of Technology

Engineering educators are familiar with the development of graduate work in engineering during the past fifteen years, and know that graduate registrations have greatly increased during this period. The increasing importance of graduate training suggests that in large metropolitan communities opportunities should be provided to enable young engineers to carry on a program of advanced study through part-time classes while regularly employed.

Beginning in 1935 the Western Society of Engineers in Chicago has directed the attention of its Education Committee to this phase of education. The Committee for 1935–36 was given the assignment of making a study of the facilities for part-time graduate education for engineers and for developing a plan whereby the Society might encourage this type of work.

The study carried out by this Committee disclosed that approximately 8000 engineers between the ages of twenty-two and thirty-four were employed in the Chicago area, and that, while adequate provision for undergraduate training was available in evening classes, very few advanced courses were being offered by Chicago colleges, aside from a limited program begun at Armour Institute of Technology in the spring of 1936. Various engineering societies had from time to time sponsored lecture courses, some of which proved quite successful, but the Committee felt that any comprehensive program should be carried out by the regularly established educational institutions. Consequently, the coöperation of the University of Illinois and the Chicago colleges and universities was invited, and a plan developed for a program of courses to begin in the fall of 1936, to be sponsored jointly by the Western Society of Engineers and the educational institutions.

As a result, graduate courses for engineers are now being offered on a part-time basis by the University of Illinois, Armour Institute of Technology, Lewis Institute, and the University of Chicago. Courses for the first semester included one class in continuous frames offered by Professor Hardy Cross, through the Extension Division of the University of Illinois, at the rooms of the Western

Society of Engineers; nine courses, including diesel engineering, heat and ventilation, alternating current networks, foundations and soil mechanics, water treatment, fuels and combustion, metallurgical materials of construction, advanced calculus and physics of electron tubes, by Armour Institute of Technology; courses in non-ferrous metallurgy, metallurgical calculations and differential equations by Lewis Institute; and electrodynamics and X-ray crystal analysis, as well as other advanced work in science, at the University College of the University of Chicago. Approximately 300 students enrolled in the combined group of courses in the fall of 1936, showing that a real demand exists for advanced work of this type.

While it is undoubtedly true that only a portion of the students enrolled are interested in working toward an advanced degree, credits obtained are recognized by the respective institutions, and the program at Armour Institute of Technology permits a properly qualified graduate to earn the Master's degree upon the completion of a minimum of eight courses. Arrangements for transfer of credits between institutions are subject to the regulations of the respective schools.

The Western Society of Engineers, functioning as a correlating agency, has made its library available to all students enrolled in these classes, irrespective of membership, and has issued announcements, covering the entire program, which have been mailed to 9000 engineering graduates.

During the current year the Education Committee of the Western Society of Engineers, including both educators and engineers, is studying the effectiveness of the program already being offered, and attempting to determine the needs for additional work of this type. To assist in this study the Committee plans to collect opinions from employers of engineers, as well as to take a census among a large number of engineering graduates, to determine the general fields of engineering in which there may be a demand for advanced study. This information will enable the colleges to closely relate their programs to the needs of engineers in the Chicago area, and should be of material assistance in planning courses for 1937–38.

Although the general program of graduate work for engineers employed in Chicago is still in a development stage, the response to the first year's work has been particularly encouraging. With proper development in succeeding years this type of work seems destined to become an important service to engineers who desire to secure additional professional training during the early years of their employment.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

By W. H. TIMBIE

Professor of Electrical Engineering and Industrial Practice

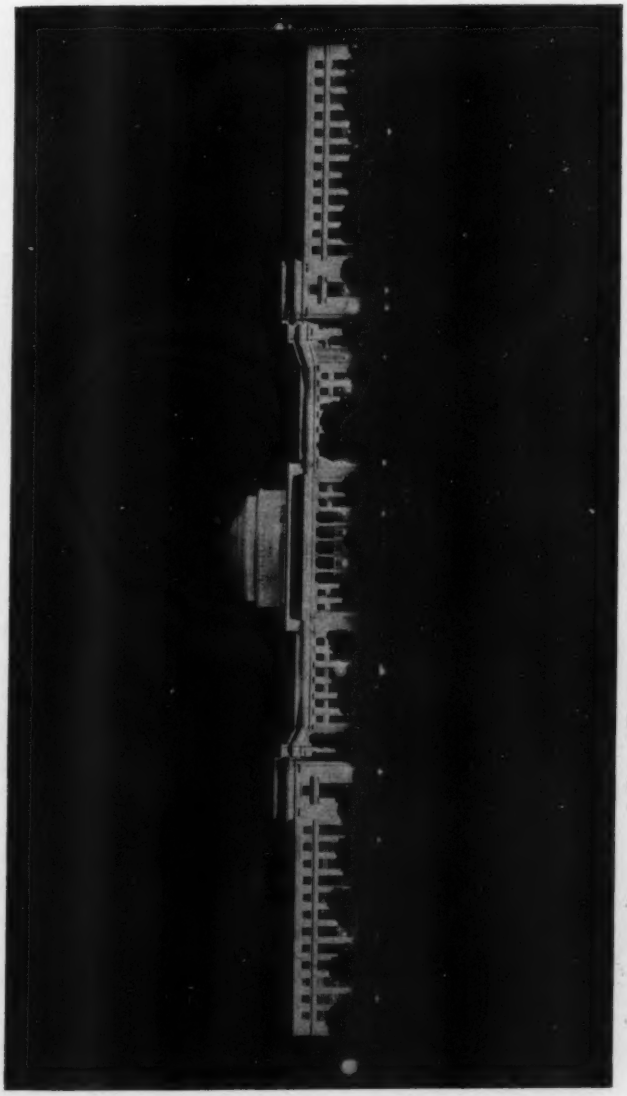
The Massachusetts Institute of Technology is an adventure in education; the endeavor to carry out a great thinker's and a great teacher's ideal of what constitutes a truly liberal education.

For years previous to the Civil War, William Barton Rogers, geologist and natural philosopher of the University of Virginia, had been thinking out his plan for an Institute of Technology. As early as 1861 he stated that the training received at such an Institute should not only impart knowledge and develop habits of exact thought but should also "help to expand more widely the elevating influences of a general scientific culture." Please note carefully the words "elevating" and "culture."

He chose Boston as the most advantageous location for his Institute because, as he said, "ever since I have known something of the knowledge-seeking spirit and the intellectual capabilities of the community in and around Boston I have felt that it was the one most certain to derive the highest benefits from a polytechnic Institute. . The occupations and interests of the great mass of the people are immediately connected with the applications of physical science, and their quick intelligence has already impressed them with just ideas of the value of scientific teaching in their daily pursuits."

In 1861 the Commonwealth granted a charter to the Institute and, as its first president, Rogers for more than ten years planned and directed its activities, instilling in the staff his own high ideals of public service and intellectual leadership. It started with fifteen students. Today it is attended by over 2700 young men and women from every state in the Union and from thirty-seven foreign countries. More than 500 students are taking postgraduate work, several departments having over fifty per cent of the total number of graduate students in the United States pursuing graduate work in particular fields. It has a staff of over 500, a plant and endowment representing an annual investment of nearly fifty million dollars, and the body of living alumni numbering 31,000 scattered throughout 82 countries.

This represents the physical growth of almost three-quarters of a century, but during this time successive generations of ad-



A Night View of the Institute from the Charles River.

ministrative officers and teaching staff have been guided by the Founder's clearly-enunciated ideal of service, and have striven throughout generations to send out graduates equipped with an education which would enable them thoroughly to understand the spirit of their own times and effectively fit in and do their share in the work of their own generation. This, we believe, constitutes a truly liberal education—an education for the greatest service, and which, in the last analysis, brings also the greatest self-satisfaction and enjoyment.

TYPICAL DISCHARGE FROM ONE UNIVERSAL OF THE VAN DE GRAAF ELECTROSTATIC GENERATOR.

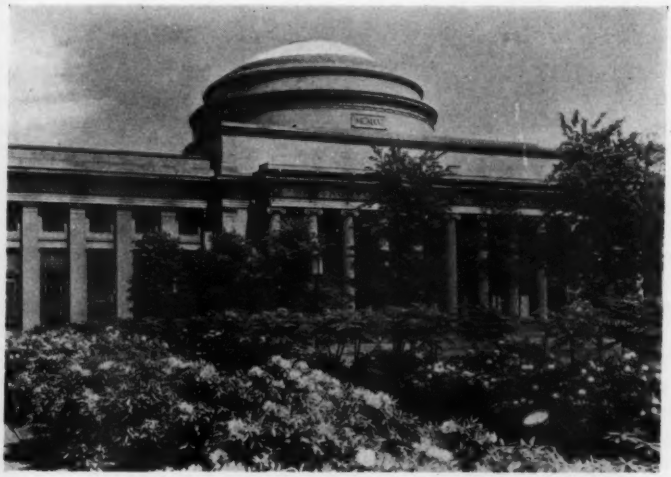
A Bird's-eye View of the Huge Model of the Cape Cod Canal Built at the Massachusetts Institute of Technology to Study in Advance the Effects of Tidal Currents in this Important Coastal Waterway.

Subjects of instruction have constantly had to be changed and new courses added to meet changing conditions and changing needs, until now upwards of 900 subjects are taught in its four schools, the School of Science, the School of Engineering, the School of Architecture and the Graduate School. This division into schools

THE MAIN HALL OF WALKER MEMORIAL. The convention dinner will be served here.

and the further division into departments is merely for the purpose of efficient administration. With the exception of the School of Architecture, all the schools are housed practically under one roof, and the Institute in its educational processes is scarcely aware of any departmental separation or barriers. It is a great coöperating educational organization in which all of the members of the staff, without regard to department, work together to carry out most effectively the high purpose of its Founder. This is perhaps best illustrated by the manner in which the large Graduate School is conducted. There is no physical separation into graduate and undergraduate buildings. The undergraduate students often work side by side with the graduate students with the resulting stimulation and inspiration of the whole undergraduate body. The question has often arisen as to whether or not M. I. T. is ever likely to become a strictly graduate school. The answer is that our experience has demonstrated that the best undergraduate instruction can be given in an atmosphere permeated by a strong graduate research program.

Perhaps the most notable advance in educational procedure at the Institute is in the greater flexibility of the curriculum, and in still more individual treatment of the student. Mass production of engineers, all modeled to the same standard educational form, must result in dead-level mediocrity in which initiative and indi-



A Corner of the Great Court at Technology.

viduality have been crushed out. Therefore, without any lessening of the emphasis on the fundamental sciences, a student is encouraged to plan his own course of study for the upper years, the prime purpose being to afford to each student the maximum of opportunity and assistance to develop his individual bents and powers to the highest degree. This does not mean that a student is allowed to scatter all over the field and get only a superficial knowledge of engineering as a whole, but rather that he has a wide choice as to the field in which he chooses to study the applications of basic principles and as to what subjects he wishes to study in order to buttress and strengthen the main stem of his course. Under such a policy the very size of the Institute becomes a real advantage rather than a hindrance to the student. The large number of subjects offered afford a wide field of choice and the small number of students per instructor (6.4) permits more individual instruction and greater personal contact between students and instructors. The practical working out of this principle of individualized student programs has naturally resulted in a wider

ELEVEN OF TECHNOLOGY'S FLEET OF 36 DINGHIES RUNNING BEFORE THE WIND FOR A CLOSE FINISH IN A RACE ON THE CHARLES RIVER BASIN.

use of Honors Groups, Seminar methods of instruction, Colloquia, and individual conferences. In addition to these educational forms, the Institute conducts coöperative courses in four departments—Mechanical, Chemical, Electrical Engineering, and Naval Architecture. These courses lead to a Master's degree and accordingly are available to those students only who give evidence of superior ability and outstanding personality.

Always maintaining that the Institute trains for life and citizenship as well as for a career, the staff seeks earnestly to cultivate in each student a strong character, high ideals, as well as a keen intellect and an awareness of the social and economic implications of their professions. To accomplish this more effectively M. I. T. has always included in its regular curricula a notably large amount of study in the so-called humanities. The emphasis placed on these studies and on the economic and social implications of engineering is aimed to give the students such a combination of humanistic, scientific and professional training as will fit them to take responsible posts in a world in which science, engineering and architecture are of basic importance.

Lastly, but by no means of least importance, should be mentioned the provision which the Institute makes for the recreational activities of its students. The conduct of athletics at M. I. T. is governed by two principles: (1) To provide exercise and healthy recreation through sports for *all* students, (2) To encourage the development of initiative and judgment among the undergraduates through student management of athletics. Toward this end the Athletic Association conducts varsity and freshman inter-collegiate athletic schedules in sixteen sports and promotes an extensive intramural athletic program. Students at Technology have ample time and opportunity to play, and a fine tradition of clean sportsmanship prevails. The latest addition to the recreational activity is the Nautical Association which offers every student an opportunity to learn sailing. A fleet of thirty-six dinghies, constituting a special Technology class, designed by Technology men, is available for sailing on the Charles River Basin. The Sailing Pavilion, located directly in front of Walker Memorial, provides a large landing float, a rigging and maintenance shop and storage space.

To our guests at this summer's convention we suggest that after you have visited our laboratories, libraries and classrooms and are surfeited with talks on engineering education, you drop in at the Sailing Pavilion and spend an hour or two before sunset, dinghy sailing on the beautiful Charles River Basin.

HARVARD UNIVERSITY

By C. L. DAWES

Associate Professor of Electrical Engineering

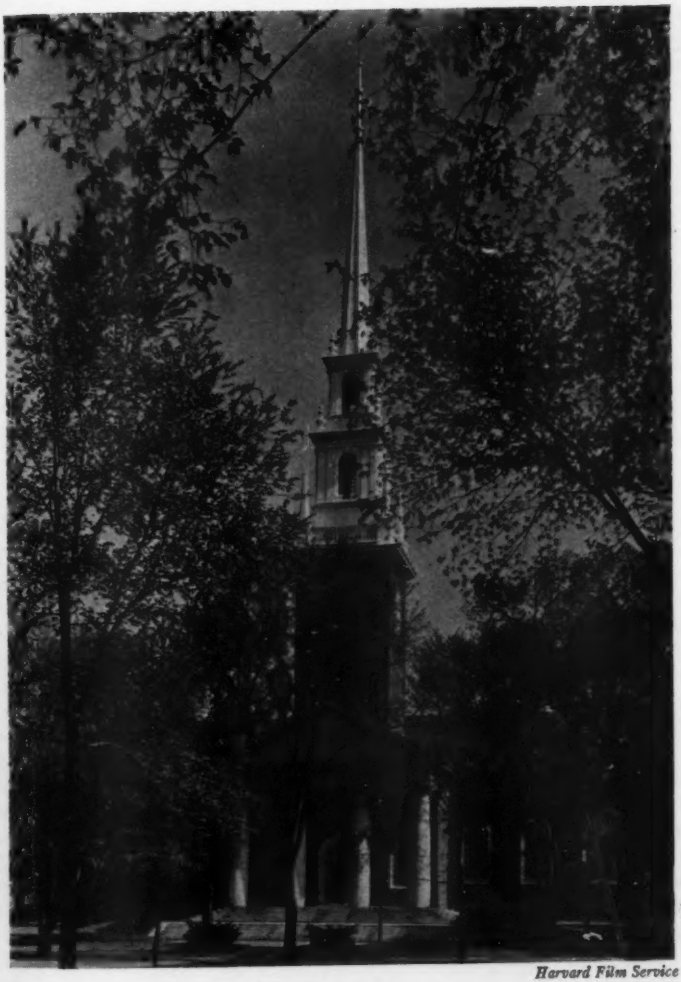
It is with pleasure that Harvard University acts with the Massachusetts Institute of Technology as host to the members of the Society for the Promotion of Engineering Education and their friends at the coming Convention. A brief history of the University and a few statements concerning its present organization may be of interest to those attending the Convention.

Harvard College, the oldest college in the United States, was founded on October 28, 1636, by vote of the General Court of Massachusetts, which also voted the sum of 400 pounds. During the past year the University celebrated its Tercentenary, marking the 300th anniversary of the founding of the College.

On November 15, 1637, the College was "ordered to bee at Newetowne" and five days later the General Court appointed the first board of Overseers, consisting of Governor Winthrop, Deputy-Governor Dudley, four other magistrates and six ministers. Within a few months they acquired an acre and an eighth of land, the nucleus of the present College Yard, together with a house in which the college was opened in 1638. On May 2, 1638, the name Newetowne had been changed to Cambridge in recognition of the English University in which most of the Overseers and many leading colonists had been educated.

On September 14, 1638, John Harvard, a Puritan minister and master of arts in Emmanuel College, Cambridge, England, died at Charlestown, Massachusetts, in his thirty-first year. The sum of £779 17s. 2d., half of his estate, and a library of over four hundred volumes were left to the new College, and the General Court on March 13, 1639 voted that the College be named Harvard College. Under Henry Dunster, a Cambridge, England, graduate, the College began with a course of study in the liberal arts, the learned tongues and three philosophies. It is interesting to note that the powers of the governing bodies, the President, Fellows and Board of Overseers, as defined by the Charter of 1650 and its Appendix, have remained unchanged up to the present time.

During the siege of Boston the College buildings were needed as barracks for the American army, so the College moved to Concord, but returned to Cambridge on June 21, 1776. Massachusetts



Harvard Film Service

MEMORIAL CHURCH.

Hall, built in 1718, the oldest college building now standing and Harvard Hall, built in 1672 and rebuilt in 1765, were used as barracks. Recognition of Harvard as a University came when the Constitution of Massachusetts, adopted in 1780, referred to "The University at Cambridge."

Harvard Film Service

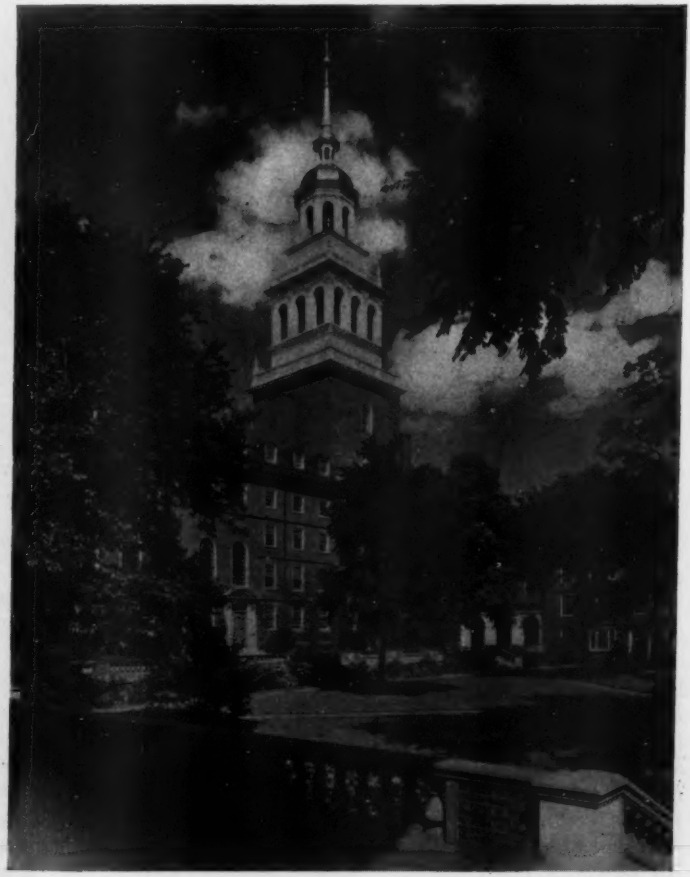
PIERCE HALL, HEADQUARTERS OF THE GRADUATE SCHOOL OF ENGINEERING.

The University now consists of Harvard College which is the undergraduate school having about 3,000 students, and the various graduate schools and departments such as Graduate School of Arts and Sciences, Law School, Medical School, Graduate School of Business Administration, Graduate School of Engineering, School of Public Health, etc. The present enrollment of the University is about 8,200.

University Hall, built in 1813–15, was designed by Bulfinch, and first was used as a students Commons Hall, the second floor being the chapel. Presidents of the United States, Monroe, Jackson and Van Buren, and also the Marquis de Lafayette were entertained at different times in University Hall. The entire building is now used for administrative purposes. It contains the President's office, the offices of deans, the Secretary to the Corporation and other administrative offices.

In the "Yard," the original site of the College, are the administration building University Hall, the Widener Memorial Library, the Memorial Chapel, several lecture halls, and the freshmen dormitories. The Harvard Union on Quincy Street is the dining hall and Commons Hall for the freshmen. Students in the three upper classes now live in the seven Houses located on or near

the Charles River. Each House has its own dining room, commons hall, library, etc. The Graduate School of Business Administration is on the Boston side of the River, opposite the Houses. Soldiers Field, containing the Stadium, the Dillon Field House and the various athletic fields, is on the Boston side of the River adjacent to the Business School.

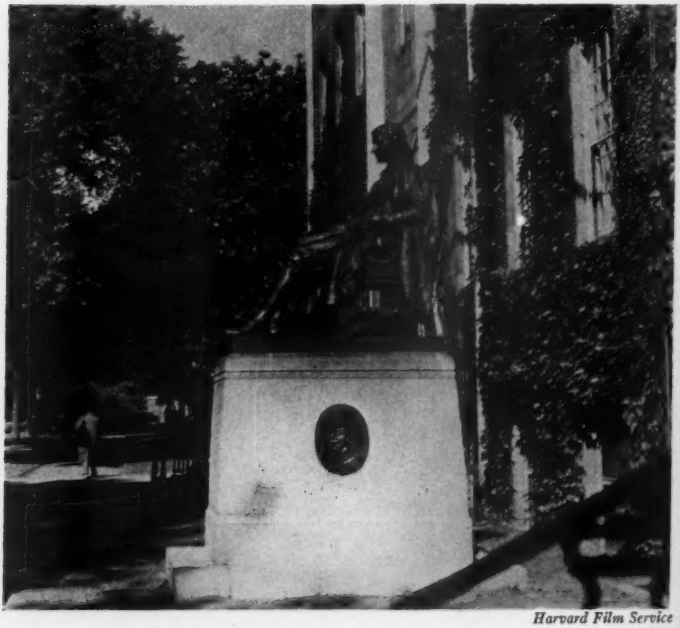


Harvard Film Service

INNER COURT, LOWELL HOUSE.

Graduate School of Engineering

The Engineering School at Harvard is the second oldest existing engineering school in the United States, Rensselaer Polytechnic Institute being the oldest. The Engineering School at Harvard was established by vote of the Harvard Corporation of February 13, 1847, its stated object being to provide a "place of systematic

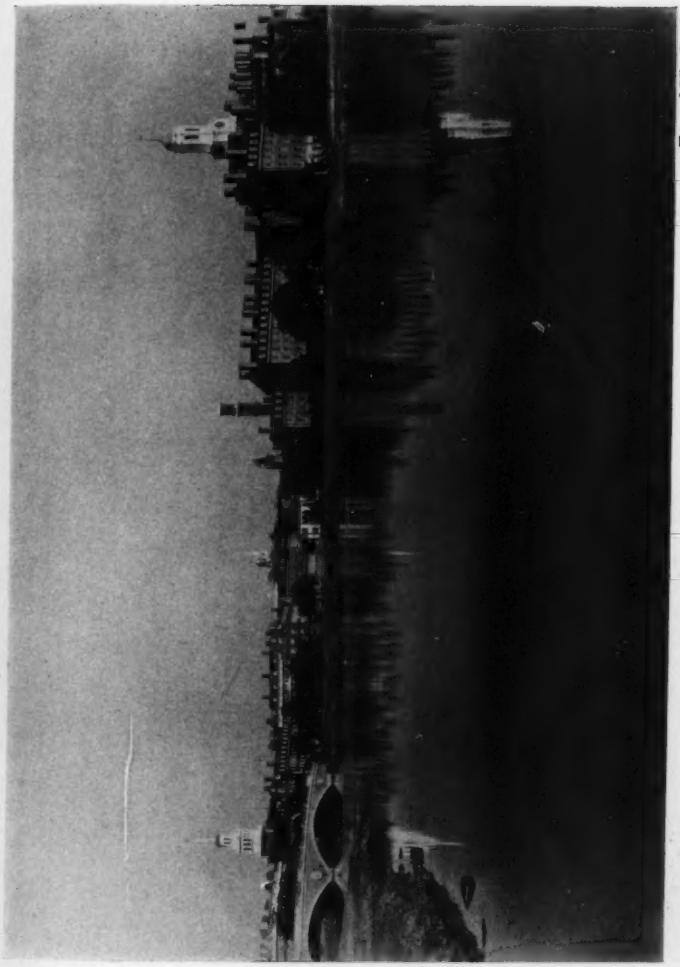


Harvard Film Service

John Harvard Statue and University Hall.

instruction in those branches of science which are immediately connected with the industrial interests of the country, such as chemistry in its various applications to the arts of life; engineering in its several departments; . . . ." In June, 1847, Abbott Lawrence gave $50,000 for the endowment of the new school which was promptly named the "Lawrence Scientific School of the University at Cambridge." About half the gift was absorbed in the building the Lawrence Hall. In 1859 Abbott Lawrence gave another $50,000 and in 1865 his son James Lawrence gave an equal sum.

The School continued as the Lawrence Scientific School until 1906. At that time a substantial bequest from Gordon McKay



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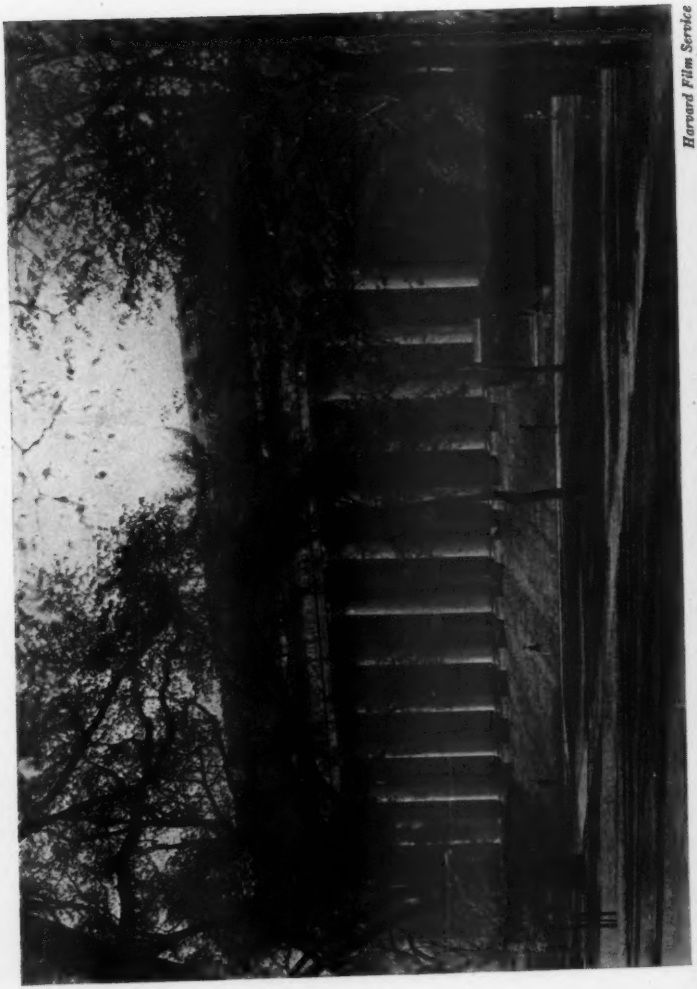
CHARLES RIVER AND THE HOUSES.



Harvard Film Service

WIDENER MEMORIAL LIBRARY.

Harvard Film Service

Widener Memorial Library.

became available and the Graduate School of Applied Science replaced the Lawrence Scientific School. This continued until 1914, when through a coöperative agreement with the Massachusetts Institute of Technology the School merged with the Institute, and instruction was conducted in the Institute Buildings in Cambridge until 1919. The courts found the coöperative agreement contrary to the terms of the Gordon McKay will, and the School moved back to Harvard in 1919, offering both undergraduate and graduate instruction. The School is now on a Graduate basis. Undergraduates interested in engineering register in the College and as a rule concentrate in the field of engineering sciences, which includes those engineering courses usually given through the third year in the usual undergraduate curriculum. Thus in the college the student obtains his work in mathematics, the sciences and basic engineering courses as well as in the cultural and humanistic studies. He also lives with, and comes in contact with men of widely varying interests. On graduation such students are given the usual liberal arts degrees, S.B. or A.B. By proper choice of undergraduate courses, the Master's degree in Engineering may be obtained in the Graduate School one year after graduation from the College.

The headquarters of the Graduate School of Engineering are in Pierce Hall, in which are also the laboratories of electrical engineering, soil mechanics and sanitary engineering; communication engineering is given in the Cruft Laboratory and the new Physics Building adjacent to Pierce Hall; the metallurgical laboratory is in Rotch Building on the same campus, and the mechanical engineering laboratories are in the Gordon McKay Laboratory nearby on Oxford Street.

Special points of interest in the University, all of which are readily accessible to the Yard, are the Faculty Room, University Hall, Widener Memorial Library, the new Memorial Church, Fogg Museum of Art, Germanic Museum, the new Geographic Building, the University Museum in which may be seen the glass flowers, Engineering School laboratories, including the High-Voltage laboratories in Pierce Hall and the 100,000-volt battery in the Cruft Laboratory, Langdell Hall (Law School) and the Baker Memorial Library (Business School). The Arnold Arboretum, a botanical garden, is in Roxbury, and the Harvard Observatory and Seismographical Station are in the town of Harvard, Massachusetts. The Blue Hill Meteorological Observatory, conducted jointly by Harvard and M. I. T., is on Blue Hill in Milton. All may be visited and are within easy driving distance of Cambridge.

ENGLISH IN ENGINEERING EDUCATION

By C. W. DUNHAM

Assistant Engineer, Port of New York Authority

A man is able to convey his thoughts to another person only as perfectly as his own means of expression and the other's understanding of it will permit. Most people in our country are limited to the use of just one tool for this purpose—the English language. How great a part it plays in our lives! How great, then, should be its development! Yet engineers are notoriously weak in their mastery of it.

In the past we have given much study to the determination of the best curricula for the undergraduate work of our engineering colleges in order to give our young engineers the best possible preparation for their life work. My own contacts with graduates for the past sixteen years indicate that the results have been good as far as technical education is concerned. However, young engineers are generally deficient in their ability to express themselves with effectiveness and facility, whether orally or in writing. Those who are really capable in this respect are the exceptions rather than the rule. Yet, unfortunately, many of the impressions which create the "Boss's" idea of a man's ability are secured through the latter's use of English. Therefore, it is tremendously important for a young man to be competent in handling this great means of conveying his thoughts and knowledge if he is successfully to hold a position of leadership among other men who are well trained in this respect.

The question naturally arises, "What can be done about it when the time and capacity of the students are already strained to the limit?"

Obviously, it is unwise to keep piling course upon course in undergraduate curricula. This should not be necessary in order to attain the desired result. Day after day the students are steeped in the study of mathematics, sciences and similar subjects, but all of these studies are carried on through the medium of the English language. Why then, cannot the development of the use of this medium itself become a well-planned though almost unconscious part of all studies?

Naturally, in this connection, the desired goal is the development of the ability to use the ordinary written and spoken words of everyday life with facility, to write concisely and well, to think

straight and to speak clearly and effectively while on one's feet before people as well as in the quiet of one's study. Not only the faculty members but the students themselves should realize the importance of these attainments.

To accomplish this goal the study of English should commence as soon as the student enters college and it should continue until he graduates. The faculty of the English Department should teach the theory of writing and effective speaking but the practice of its teachings should be carried out day after day in the other departments by having the closest kind of coöperation among them all. The English professors in a few hours each week should not be expected to counteract the effect of careless or bad habits formed elsewhere. These other departments should insist that all written examinations, reports, theses and similar work of the students must be satisfactory in composition as well as in subject matter. Oral interrogations or recitations should be held in order to give valuable practice in quick thinking and extemporaneous speaking. These last will also give the students the incidental benefit of listening to the questions and answers of others.

Of course, such a program will require painstaking work on the part of the teachers. However, the possibilities for real service are too great to be neglected.

The classroom is not the only place where practice in the use of the English language should take place. Competition in public speaking, participation in the work of the college paper, preparation of essays and their presentation at meetings of the student branches of the engineering societies, discussion of such essays, prepared and extemporaneous debates and similar activities should be a regular part of the college life.

I shall try to illustrate the need of this training and its benefits by giving a few examples from the experiences of engineers whom I know. All are true cases even though the names of the individuals are not disclosed.

A chief engineer wanted someone to study a certain bridge project and to make a report upon his findings. As it happened, the engineer who usually did such work for him was on his vacation, therefore, the problem was assigned to a younger man. The latter made the necessary investigation and estimate, then hastily compiled his report. He delivered it in person to the chief engineer. The latter read it in the presence of the assistant chief engineer and the author. He figuratively tore it to pieces because of its poor form and composition although he did not criticize the correctness of the figures. Obviously, that young engineer suffered much more than injury to his feelings.

In another instance a young designer was asked to help with some

specification writing during an emergency. He soon demonstrated such clearness and exactness in writing that he was transferred to this part of the organization, receiving at the same time a substantial raise in salary and an advance in title. Some of his fellows failed to realize that the reason for his promotion was an accomplishment whose value they had overlooked.

The preparation of specifications is a good example of the need for exactness in writing. Repeatedly, trouble develops from their indefiniteness or misinterpretation of them. One case centered upon one short descriptive phrase of four words which the contractor claimed meant something entirely different from the intention of the author. The dispute was finally settled with a loss of about $75,000 to the owner.

In another instance a company wished to carry on a lecture program to advertise its engineering services. One of the concern's lawyers was assigned to the job. After the first attempt he was recalled because he did not have the technical background to answer the questions put to him. An engineer was then sent out to carry on the work. His knowledge was sufficient but his presentation of the subject was so uninteresting that he too was recalled immediately. The program finally had to be finished by a few of the men higher up in the company who took turns at the job. The effect of this affair upon the first two men needs no comment.

A different kind of case is that of a company which sent one of its engineers to confer with a customer about difficulties which had arisen between them. The engineer understood the matter well enough but he could not discuss the details calmly and clearly. He soon became antagonistic in his attitude and failed miserably in his mission. The result was an oral order by the chief engineer stating that this man must never again be permitted to represent the company in such matters. His future progress was wrecked. One might say that this case represents poor character rather than weakness in the use of the English language. However, knowing the individual as I do, I believe that his failure was due largely to inexperience in debate and in controlling his speech under difficult circumstances.

Another case concerned two young engineers who were about equal in technical ability. The first seemed to be afraid to express himself and to present his views. When he attempted to do so he was inclined to be hesitant and unconvincing in his speech. The second was unafraid, forceful, yet tactful and clear in his discussions. The result was that the second young man steadily forged ahead of the other. Such things have happened too frequently to be commented upon further.

It seems to me that there are two sides to this matter of correct

and effective use of English which one should master. The first is the attainment of a good vocabulary and knowledge of what is right and proper composition. The second is the development of courage and ability to get on one's feet, to say something worth while and to say it well. These can be mastered by the students only if they are given long-continued practice in writing and speaking in college until they become so accustomed to expressing themselves properly that eventually they are able to concentrate their minds upon their ideas rather than upon the search for words to express those ideas.

In conclusion, let me urge that proficiency in the use of the English language be given one of the chief places among the goals to be striven for by our engineering students. Let it be attained by the whole-hearted coöperation of the entire faculty of the colleges. Thus will our young engineers go forth to Life possessing one of the great qualifications for success.

CONFERENCE ON ENGINEERING RESEARCH*

The purpose of this conference was two-fold: (1) To discuss along rather broad lines the activity of other groups and organizations in the coördination of engineering research, and (2) To invite suggestions for a definite program of activity for the Society's Committee on Engineering Research supplementing as best it can the work of coördinate committees of other societies.

In years past the Committee on Engineering Research has done much to stimulate interest in research and to compile a census of current and completed investigations. During the year 1929–1930, for example, R. A. Seaton, H. H. Higbie, and C. F. Harding respectively brought up to date a summary of engineering research activity in the non-land-grant colleges and universities of North America, presented a list of projects suggested by industry, and discussed the pros and cons of coöperative research between industries and universities.†

Six years have elapsed since those reports were current. Research workers have been active. Research committees have been authorized by technical and scientific societies. Research clearing houses have been operative in narrowly specialized fields of investigation. Yet, by and large, we must look to individuals rather than to groups for an answer to the questions, "What is being done in this or that field of research in this country?" "What agencies are keeping their fingers on the pulse of research activity in the engineering schools of the country?"

Four papers were presented in a SYMPOSIUM ON THE COÖRDINATION OF ENGINEERING RESEARCH outlining engineering research activities of—

The National Research Council, by Dean J. W. Barker, Columbia University;
The American Society of Civil Engineers, by Dean Thorndike Saville, New York University;
The Association of Land-Grant Colleges and Universities, by Dean Blake R. Van Leer, University of Florida;
Individual Graduate Schools, by Dean S. C. Hollister, Cornell University.

More than 70 members were present at the conference.

* Held in connection with the 44th Annual Meeting, S. P. E. E., University of Wisconsin, Madison, June 23, 1936.

† JOURNAL OF ENGINEERING EDUCATION, Supplement to February, 1931.

Dean Barker outlined briefly the work of the National Research Council's Committee on Bridging the Gap between University and Industry of which he is chairman. Information is being gathered as to types of research conducted in engineering schools through regional conferences of committee members with deans of engineering colleges and directors of experiment stations in the region. The United States was divided into seven regions and during the past three years conferences have been held in four regions. It is expected that the preliminary work will be completed in another year. He added that industry usually turned to the larger schools for information on research projects and relied largely on published reports. Hence, there is a considerable time lag between the completion of an investigation and the application of its findings industrially.

The papers presented by Dean Saville and Dean Van Leer appear on the following pages.

Dean Hollister urged that the individual graduate schools confine their attention largely to the fundamentals of research, the securing of answers to definite problems, and the training of men to get such answers. He expressed the view that it was the field of S. P. E. E. to report on methods of instruction and procedure, rather than on research projects.

Prof. F. M. Dawson, University of Wisconsin, questioned the value of research reports such as those published by the Association of Land Grant Colleges and Universities. Dean H. B. Dirks, Michigan State College, editor of the *Bulletin*, replied he was able to publish only material which he received from the several schools, and he felt the information in the *Bulletin* to be of value even if only the title and purpose of the research projects were stated. He added that each of the 48 members of the Association paid $10 a year toward this service and that $200 was spent annually on the *Quarterly Record*.

President H. S. Rogers, Brooklyn Polytechnic Institute, discussed three classes of research projects from the standpoint of methods of supporting them: (1) Projects carried along on marginal time, (2) Projects intended to train graduate students, and (3) Projects subsidized directly, as through experiment stations. He stated that a research staff should be organized around a given problem; that administrators should make research positions available to more men; and that the work of trade associations in research should be coördinated. He added that a committee of S. P. E. E. could act informally as a clearing house for research problems.

F. T. MAVIS, *Chairman*
J. W. HOWE, *Secretary of the Conference*

THE COMMITTEE ON RESEARCH OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

By THORNDIKE SAVILLE

Dean, College of Engineering, New York University

The By-Laws of the Society provide that the Committee on Research shall be "advisory to the Board of Direction on matters of a major research character as to program and personnel and be supervisory of such special research committees as are . . . assigned to it." The Committee consists of "one Board member and four non-Board members each appointed for four years, so that one membership will cease annually." The members of the present committee and the dates of expiration of their appointment follow: Thorndike Saville, *Chairman* (1937); Fred C. Scobey, *Secretary* (1938); Albert F. Reichmann (1939); W. J. Mead (1940); Charles B. Burdick, Contact Member representing Board of Direction.

For a number of years prior to 1935 on account of the economy measures of the Society the Committee on Research held no meetings, and functioned chiefly as an agency for collecting reports from the several special research committees and transmitting them to the Board of Direction. In 1935 the Committee became more active and requested instructions from the Secretary of the Society as to its definite powers and the extent to which it might exercise authority over research activities of the Society with the double objective of stimulating and coördinating such activities, and of recommending to the Board of Direction the discharge of research committees whose assignments are completed or whose efforts are not actively adding to engineering knowledge.

Acting on instructions given it, the Committee on Research held a meeting in April, 1935, and proceeded to consider reports from the existing special research committees assigned to its jurisdiction. These are:

1. Committee on Stresses in Railroad Track, A. N. Talbot, Chairman.
2. Committee on Cement, Thaddeus Merriman, Chairman.
3. Committee on Concrete and Reinforced Concrete Arches, Clyde T. Morris, Chairman. (Final report now published and the committee discharged in October 1935 at request of the Chairman.)
4. Committee on Earths and Foundations, Lazarus White, Chairman.
5. Committee on Dams, Thaddeus Merriman, Chairman.
6. Committee on Meteorological Data, Donald M. Baker, Chairman.

7. Committee on Hydraulic Research, J. C. Stevens, Chairman.
8. Committee on Food Protection Data, Gerard H. Matthes, Chairman.

The Committee on Research not only undertook to obtain progress reports from these special committees, but to determine (*a*) the justifiable expenditures required for continuation of their work; (*b*) whether the personnel of the committees should be altered; and (*c*) the probable time within which the duties of the committees might reasonably be expected to be completed. Inquiries were also made as to activities in the same or related subjects being undertaken by committees of other technical societies.

The Committee on Stresses in Railway Track works in coöperation with and under grants from the American Railway Engineering Association. Its present activities are chiefly concerned with studies on welded rails, effects of locomotive counterbalance upon rail stresses, rail profiles at or near rail joints, properties of the tie-plates, and super-elevation of track for high speed trains. The committee has been highly productive in the past, and is engaged upon significant studies at present.

The Committee on Cement acts as a contact committee with the Committee C–1 of the American Society for Testing Materials and with other engineering committees and societies interested in cement. Among the items studied are the composition of cement with respect to its behavior in service and the development of a sodium sulphate test for cement durability. This test has been adopted by the Bureau of Reclamation for the All-American Canal and by the War Department for the Bonneville and Fort Peck Projects. The Committee is now working on a sugar solubility test that will, it is hoped, enable the completeness to which a cement has been calcined to be determined in a few hours.

The Committee on Concrete and Reinforced Concrete Arches has had a distinguished record. Its final report was published in Vol. 100, *Transactions*, Am. Soc. C. E.

The Committee on Earths and Foundations has acted not only as a coördinating and reporting committee, but also has under its own auspices conducted important experiments on soils and foundations. It is working in coöperation with specialists in several universities both in this country and abroad. A number of its recent activities appear in the October 7, 1935, report of Engineering Foundation through which it has received funds for some of its investigations. The Committee is assisting financially the following investigations: (1) The study of lateral earth pressures, by Professor Bucky, of Columbia University, who has designed and built an elaborate apparatus whereby the combination of the

centrifuge and photo-elastic methods makes visible and measurable such pressures. (2) The study of the consolidation of clay, under the direction of Arthur Casagrande, of Harvard University. (3) The settlement of structures, by Prof. Charles Terzaghi, of the Technische Hochschule, Vienna, Austria. (4) The holding power of piles and sheeting, under the direction of Prof. D. P. Krynine, of Yale University. (5) The general field of soil mechanics, under the direction of Prof. Glennon Gilboy, of Massachusetts Institute of Technology, and (6) Advanced methods of computing lateral earth pressures, by Lazarus White and George Paaswell. The correlation of the data so obtained, and the preparation of reports to the Society are, unfortunately, slow processes. The Committee expects to submit reports on several of the aforementioned subjects in the near future. The closing discussion of the Committee's progress report which appeared in *Proceedings*, Am. Soc. C. E., May, 1933, has been submitted to the Society.

The Committee on Dams has reported little progress, confining itself hitherto largely to the subject of uplift pressures. It circulated a world-wide questionnaire on this subject in 1932. A paper by D. C. Henny of this Committee has been published by the Society.

The Committee on Meteorological Data submitted a vigorous progress report in 1931 analyzing and constructively criticizing the U. S. Weather Bureau with respect to service to the engineering profession. Largely as a result of the interest in and discussion of this report the Science Advisory Committee of the National Research Council added J. B. Lippincott, M. Am. Soc. C. E., to its sub-committee on the Weather Bureau. The Committee on Meteorological Data has coöperated with federal agencies whose activities relate to the Committee's functions. The Committee on Research endorsed the continuance of this committee, but recommends the presentation of a more definite program of activities in 1936.

The Committee on Hydraulic Research was constituted in 1933. Its first undertakings, still in progress, comprise: (1) Letter Symbols for Model Studies. A set of symbols that can be adopted as a standard for model work is being prepared. (2) Conformity of Model to Prototype. All information obtainable is being gathered to show the conformity of structures to model behavior. In some cases the structures are being tested after having been constructed along lines set forth by model studies. In such cases the Committee is urging the installation of facilities for testing after completion. In other cases, models of existing structures have been built and tested. In time some valuable data will be available along this line. (3) Manual of Laboratory Practice. The Committee is preparing a brief manual of standard practice in construction and operation of models.

Early this spring the Committee on Hydraulic Research, of which J. C. Stevens is Chairman, undertook an ambitious program, financed partly by the Society and partly by Engineering Foundation. The program includes the following specific research problems: (1) Conversion of kinetic to potential energy, assigned to Prof. F. T. Mavis, of the State University of Iowa; (2) Travelling waves on steep slopes, assigned to Prof. Harold A. Thomas, of Carnegie Institute of Technology; (3) The phenomena of intersecting streams, assigned to Prof. M. P. O'Brien, of the University of California; (4) Curves in open channels, assigned to Prof. C. A. Mockmore, of Oregon State College; and (5) Sedimentation at the confluence of rivers, assigned to Prof. L. G. Straub, of the University of Minnesota.

The Committee on Flood Protection Data was re-constituted in 1934 at the request of the Mississippi Valley Committee of the Public Works Administration to act as an advisory body in connection with a study of flood flows in the United States. The Committee held a number of meetings in Washington and contributed extremely valuable advice and guidance in the prosecution of flood flow investigations and in the preparation of *Water Supply Paper* No. 771 of the U. S. Geological Survey. The Committee has made valuable suggestions as to its future program, particularly as it may relate to studies of the economics of flood control, and as a contact agency between the Society and federal and local agencies engaged in flood studies. The report of the Committee was published in *Proceedings*, Am. Soc. C. E., February, 1936.

For the foregoing research activities, the Society is contributing about $6,000 during the current year. Additional funds of moderate amount have been provided by Engineering Foundation for special studies indicated.

The research activities of the American Society of Civil Engineers are by no means confined to the formal programs carried on by the special research committees. There are numerous research programs being prosecuted by Committees of the several Technical Divisions of the Society which are too numerous to mention here. For example, there are more than fifteen committees dealing with special phases of research in water and sewage problems alone.

The Committee on Research has on its agenda for the present year consideration of procedures whereby the more or less scattered and sometimes overlapping research activities of the Society may be critically examined and coördinated to the end that a comprehensive and cohesive plan for such activities may be recommended to the Board of Direction.

It is the belief of the writer that the present undertaking of the Committee on Research of the Society for the Promotion of En-

gineering Education looking toward coördination of engineering research is in line with the activities of the similar committee of the American Society of Civil Engineers, and that the latter will be glad to participate heartily in activities designed to provide a medium of exchanging information on research projects being prosecuted by various organizations.

WHAT THE ASSOCIATION OF LAND-GRANT COLLEGES MIGHT DO

By BLAKE R. VAN LEER

Dean, College of Engineering, University of Florida

The thoughts set forth below are predicated upon the following assumptions:

1. The regimentation or control of engineering research is not practical, feasible or desirable.
2. There is need for better facilities for exchanging information on research projects, methods of attack, results, failures, and successes.
3. Engineering college faculties are already overburdened by the multiplicity of organizations which they are called upon to join and the number of meetings per year demanding their attention.

It is recognized that the National Research Council, the technical societies such as Am. Soc. C. E., the S. P. E. E. and the several graduate schools are all interested in any program which will aid and simplify their efforts to promote and accomplish more engineering research. The question is: How can this best be performed with a minimum of cost to the various institutions and a minimum demand upon the time of the research workers?

One desirable aid which can be extended, one which has many times been suggested, and one which several agencies attempt to render in part is the frequent and regular publication of a list of projects in operation in the several research institutions. To accomplish this aid requires the following:

1. A method and agency for assembling, frequently and regularly, the required data.
2. An editorial and compiling agency.
3. Money with which to publish the results.
4. At least a yearly meeting or forum at which may be discussed and criticized the procedure, and through which could be furnished the administrative and self-perpetuating machinery of operation.

There are several agencies which approximately meet all of those requirements: For example, the S. P. E. E., the technical societies, the Association of Land-Grant Colleges and Universities, the National Research Council, and individual graduate schools. Let us take each of these agencies and see wherein it falls short of meeting the needs and desires of all concerned.

1. The S. P. E. E. has never shown a great deal of interest in rendering such an aid, primarily I presume because its funds are so limited that it has not sufficient money to publish even all the worthwhile papers submitted to it, much less a long list of research projects most of which would interest only a small percentage of its membership. The S. P. E. E., therefore, lacks funds and interest.

2. The technical societies are very much interested in engineering research, but they are much more interested in the final results—in papers, problems and performances—than in coördinating research in any but very highly specialized fields. Some of these societies have some notable achievements to their credit in certain fields, but no single technical society could or would attempt to cover the entire field of engineering research. They lack the interest, means of collecting the information, and the universal interest needed.

3. The National Research Council was organized apparently for this primary purpose; however, up to the present time, it has done very little. It has not been able to set up and perfect the machinery for collecting the information. It has no regular publication. It has spent its funds primarily in promoting new fields of investigation.

4. It is out of the question for individual graduate schools to do this task. They have neither the machinery, the publication, nor the democratic method of control needed; and I know of no school which could or would assume that financial burden for all the rest. Ohio State University's Engineering Experiment Station attempts a service somewhat along this line by the publication of its bulletins.

5. The Association of Land-Grant Colleges and Universities is now attempting to render to its members exactly this service. The service is not now entirely adequate, primarily because some institutions which are carrying on engineering research are not members of the Association. This, I believe, could be remedied. I have no authority to speak for the Association of Land-Grant Colleges and Universities, but I am sure they would welcome the participation of other institutions in this service. The annual meeting of the Association is generally attended by representatives of other engineering research institutions of higher learning. Furthermore, the bulk of the engineering research carried on to-day outside of commercial or industrial concerns is carried on by the engineering experiment

stations of the land-grant colleges. I believe this will continue to be so.

There is no likelihood of the Association of Land-Grant Colleges and Universities abandoning the service which it is now rendering to its members, Hence, in order to prevent duplication and confusion, I recommend that a committee be appointed to study this problem further and render a report to the S. P. E. E. Council, making specific recommendations relative thereto; that the committee specifically ascertain whether or not the Association of Land-Grant Colleges and Universities would welcome the participation in its Bulletin of Engineering Experiment Stations all other engineering research institutions and upon what terms or conditions.

PRELIMINARY ANNOUNCEMENT OF 1937 SUMMER CONFERENCE ON THE TEACHING OF MECHANICAL ENGINEERING

A Summer Conference on the Teaching of Mechanical Engineering will be held at Cambridge on June 28th and 29th, preceding the annual meeting of the Society. The conference will be under the auspices of the Committee on Mechanical Engineering.

The keynote of the conference will be The Improvement of the Curriculum and of Methods of Teaching Mechanical Engineering. In addition to the presentation of papers by leading educators, an evening will be devoted to round-table discussions, a reunion luncheon will be held by those who attended the Summer School for Mechanical Engineering which was held at Purdue University in 1929, and a dinner will be held on Tuesday evening, June 29th.

The detailed program will be announced at a later date.

FRANK L. EIDMANN,
Chairman, Committee on Mechanical Engineering

REPORT OF COMMITTEE ON TESTS AND COMPREHENSIVE EXAMINATIONS

Your present Committee on Tests and Comprehensive Examinations was created at the Purdue meeting in 1931, in response to an insistent demand by a group of engineering colleges and engineering teachers very definitely and vitally interested in coöperating in the use of comprehensive, psychological, aptitude, and objective classroom tests in engineering education. They were interested in such diverse use of tests as the measurement of scholastic aptitudes of entering freshmen classes; the measurement of special aptitudes; measurement of engineering students at the close of sophomore and senior years; and systematic use of test results both for selection and guidance of students, for class sectioning, and for prediction of graduation at the end of a four year period of study. And they were interested in an interchange of ideas, data and methods.

The group which comprised the first committee personnel, and the present membership, in reviewing the past connection of this Society with the development of the general testing program in this country, felt and feels still that both the Society and the Committee have a great heritage through this participation and these contacts the past two decades. Through activities of previous S. P. E. E. test committees, and of its Board of Investigation and Coördination, a tremendous interest along these lines has been aroused in and among engineering colleges and teachers. Neither has this interest been confined to engineering colleges. In fact, there seems to be evidence that an even greater interest has been aroused in many of the non-engineering schools, particularly in those of good standing but small size. In general the result has been greatly increased administration of tests of all the kinds named, more intensive programs involving test construction and standardization, sectioning on the basis of ability, selection and guidance, and prediction of graduation.

"*The big problem before the engineering schools of America is the selection of the material which goes to make up our student body.* The engineer is rapidly passing out of the role of 'hired man,' whose technical knowledge and ability is used to carry out the technical details of the schemes of promoters, the greater number of whom are bankers, business men, politicians, and the like. The engineer is becoming interested in what the results of his labors are going to be used for. He is beginning to inquire what it is all about. This is

a very hopeful sign, that more and more the engineer will be the man who will decide *whether a thing should be done at all*, rather than *how it should be done*, especially from a technical and engineering standpoint. To equip the younger engineers for this type of work, of course, the curricula of engineering schools may need some revamping, but not much. Probably it will mean a change of emphasis rather than the introduction of very many new courses. *The great change is more likely to be in the type of student that we try to equip in this way.* A student of this type has been described simply and yet vividly by an official of one of the largest successful organizations in the country as 'a good boy, with a sound body, a superior mind, who knows his stuff, and has the vital spark to set him off.'

"If the colleges are to accept these specifications for defining the most effective type of engineering graduate, it might be well for us to see what can be done to meet them. In the first place, several of the qualities looked for are qualities in the development of which we have very little to do. With regard to these four specifications, viz.: 'a good boy,' 'sound body,' 'superior mind,' and 'vital spark,' the big task of the college is the matter of selection, granting, of course, that we are always on the alert not to contaminate the boy's goodness, enfeeble his sound body, dull his superior mind, or quench the vital spark, in our effort to equip him with the 'stuff' which industry feels he must know."

Historical Setting of Present Committee Work

Your committee feels that it is, or should be, committed to the task of carrying forth the work inaugurated by this Society and its former committees on tests and examinations, and to the gathering together and disseminating to interested teachers and colleges the results of such testing. In order to set forth what this Society has already done, as well as to clarify the position of the present committee, let us briefly review a few historical facts.

The "Mann Report" on Engineering Education, so generally discussed by members of our Society in 1918 and 1919, focused attention on the advantages of use of objective classroom tests and psychological tests for measurement of aptitude and achievement of engineering students. That report, together with results of administration of the Army Alpha and Beta Tests during World War times, so stimulated Society interest in the testing program that at the Baltimore meeting in 1919 the Society appointed a special Committee on Intelligence Tests, on recommendation of its Committee on Admissions, to experiment with and conduct researches respecting objective, psychological, and "trade" tests; and to determine what relationships, if any, might be discovered

between test scores made by freshmen engineering students and their scholastic work in course. L. L. Thurstone, then at Carnegie Institute of Technology, was made chairman of this new committee, as he had been experimenting for some years with various engineering aptitude tests of his own design. As a student he had received training in mechanical engineering, and this Society should note with much satisfaction and interest that his Psychological Examination, now sponsored by the American Council on Education, and which grew out of this Society's first experimental use of it, now seems to occupy a prominent place of all psychological examinations being given to engineering students, as Table 2 of this report shows. Your committee desires furthermore to take official note of Dr. Thurstone's most recent researches in the analysis of the separate factors of intelligence. His theory and method of "factor analysis," and his segregation of seven "primary colors of personality" (number facility, word fluency, visualizing ability, memory, perceptual speed, induction, and verbal reasoning) may have high significance in the future measurement of engineering students.

Following again the thread of history, forty-nine engineering colleges (and some other institutions) coöperated with this Society in administering the Thurstone tests to some 7,000 engineering and other students. Each test included six units, covering problems in arithmetic, algebra, geometric constructions, and physics. A fifth unit covered technical information, and the sixth was an original form of Thurstone's psychological test. Final results and reports were not available until 1923, after the Society's attention had become centered in making its great national study of engineering education. This was unfortunate, for it seems to have interfered with a careful evaluation of all the test results secured. As we look back now at the order of coefficients of correlation obtained between test scores and scholastic achievement, they would not be considered high, as they ranged from 0.30 to 0.45. However, they were good for that period in the history of testing.

As a part of its study of engineering education, this Society suggested administration of the Iowa Placement Tests by all interested engineering colleges. This came about through recommendation by Dean C. E. Seashore, member of our Board of Investigation and Coördination. Two separate reports on the results have been published, one written by G. D. Stoddard, author of the tests, published by Iowa State University; and the other compiled by H. P. Hammond and G. D. Stoddard, published by this Society as Bulletin No. 15, and also as part of the final report of the Board of Investigation and Coördination. Correlations between test scores and respective course grades in chemistry, English, mathematics,

and physics this time ranged from 0.50 to 0.77. This represented a very decided improvement in test construction and administration.

A brief survey which members of the Committee have conducted has disclosed the fact that out of ninety-four which have reported some 78 per cent of the institutions of the United States in which engineering instruction and degrees are given are now administering at least one test by means of which preparation and ability of entering engineering freshmen are measured. A similar survey made by members of the Engineering Drawing Division of this Society the spring of 1929 showed that 24.5 per cent of these same institutions were at that time giving at least one such test. Numbers of institutions have reported that the beginning of their organized test program was subsequent to 1930. The evidence is that testing and guidance programs in our engineering colleges is very much on the increase.

The extent to which the Iowa Placement tests have been used since 1924, and are now being used, is partially indicated by Tables 1 and 2 of this report. Many more tests have been given to engineering students in the institutions involved than these tables show, due to the fact that many schools, in reporting to this Committee, stated that they were using the various tests, but did not supply the number of students tested.

The Coöperative tests are being given in a large number of engineering colleges as Table 2 shows, and are being sponsored also by Engineers' Council for Professional Development. The Coöperative Test in Physics is being widely tried out by the American Association of Physics Teachers, in collaboration with the American Council on Education. The *"American Physics Teacher"* for September, 1935, shows that some 269 departments of college physics are using these tests, and that of this number 42 of the departments are in schools giving instruction in engineering. Other teachers in engineering colleges could well afford to coöperate together as these teachers of physics are doing in the effort to bring about a higher type of college testing and of pre-determining preparation for taking particular courses. Your committee has assembled a partial bibliography covering papers by faculty representatives and others which describe various aspects of the use of all the tests named in the four tables.

TABLE 1

SHOWING THE NUMBER OF INSTITUTIONS GRANTING ENGINEERING DEGREES INVOLVED IN THIS STUDY. ALSO THE NUMBER OF COLLEGES REPORTING THAT THEY GIVE IOWA, COÖPERATIVE, OR OTHER TESTS

Number of Colleges questionnaired	130	100%
Number of same that sent no replies	36	27.69%
Number furnishing replies	94	72.31%
Of the 94 institutions which furnished replies:	94	100%
Institutions that have used 1 or more Iowa Tests	39	41.50%
1 or more Coöperative Tests	21	22.30%
Institutions that give either Iowa or Coöperative Tests, or both together	50	53.19%
Institutions that use both Iowa and Coöperative Tests	12	13.04%
Schools that use some test, or tests, but neither the Iowa nor Coöperative Tests	24	25.50%
Of the 94 Schools, those that give no tests whatever	20	21.28%
those that give 1 or more tests	74	78.72%
Of the 74 that give tests:		
Schools giving the Iowa Tests only	1	1.35
giving Iowa and Coöperative Tests only	3	4.05
giving Iowa and tests other than Coöperative	26	35.14
giving Coöperative and tests other than Iowa	9	12.16
giving Coöperative Tests only	2	2.70
giving Iowa, Coöperative, and other tests	9	12.16
giving neither Iowa nor Coöperative Tests but some others	24	*32.44
	74	100.00

Schools using the tests for sectioning:

	Yes	No	No Reply
Chemistry	15	21	38
Drawing	4	19	51
English	32	12	30
Mathematics	24	14	36
Physics	5	26	43

Schools using test results for purposes indicated:

	Yes	No
Vocational Guidance	49	13
Prediction of Graduation	25	19
Diagnosis and Remedial Measures	5	0
Job Placement	2	0
Selective Admission	6	0
As Exemption Tests	1	0
For Other Purposes	31	0

TABLE 2

SHOWING APPROXIMATELY THE USE OF PLACEMENT TESTS AND PSYCHOLOGICAL EXAMINATIONS IN 94 OF 130 INSTITUTIONS OF THE UNITED STATES IN WHICH ENGINEERING INSTRUCTION IS GIVEN AND DEGREES AWARDED

Group A—Iowa Placement and Other Iowa Examinations

Name of Test	Number of Institutions Giving Test	Number of Students			Used for Sectioning
		Engineering	Non-Engr.	Total	
Chemistry Aptitude	12	14,214	4,572	18,836	Yes
Chemistry Training	7	6,612	130	7,281	"
English Aptitude	17	12,097	5,959	18,806	"
English Training	16	13,438	14,872	34,210	"
Mathematics Aptitude	15	16,126	4,364	20,940	"
Mathematics Training	14	23,711	4,457	30,018	"
Physics Aptitude	8	9,198	4,000	13,248	"
Physics Training	5	4,142	100	4,342	"
High School Content	6	3,328	7,154	10,482	"
Iowa Comprehension	1	65	323	388	"
Iowa Reading	3	552	3,146	4,198	"

Group B—The Coöperative Tests, Sponsored by the American Council on Education

Name of Test	Number of Institutions Giving Test	Number of Students			Used for Sectioning
		Engineering	Non-Engr.	Total	
Chemistry	1	95	—	95	Yes
English	17	6,420	11,135	18,476	"
Mathematics	13	5,654	6,001	11,655	"
Algebra	1	87	116	193	"
Physics	8	3,091	1,387	4,478	"
Physics—reported by Amer. Council on Education, as having given tests	34	—	—	—	—

Group C—Placement Tests in Subject Named, Constructed by and Used Locally in Individual Colleges

Name of Test	Number of Institutions Giving Test	Number of Students			Used for Sectioning
		Engineering	Non-Engr.	Total	
Chemistry	6	5,767	7,426	13,493	Yes
English	12	10,420	14,554	25,974	8, yes
Engineering Drawing	5	1,700	0	1,700	Yes
Mathematics	9	6,257	1,139	7,696	7, yes
Physics	3	600	0	1,200	1, yes
Mineralogy	1	135	0	135	Yes

TABLE 2—*Continued*

Group D—General Psychological Tests

Name of Test	Number of Institutions Giving Test	Number of Students			Used for Sectioning
		Engineering	Non-Engr.	Total	
American Council and Thurstone	34	24,831	45,395	71,586	Yes
Thorndike	6	2,100	12,494	32,604	"
Ohio State Forms 17 and 18	6	7,154	38,445	42,833	"
Otis Psychological	4	1,330	4,648	5,978	"
Psychological (not named)	8	1,486	7,450	31,936	"
Carnegie Mental	2	3,300	2,750	6,050	"
Army Alpha, Wells Revision	3	2,300	922	3,772	No
Bernreuter Pers. Invent.	5	2,300	319	3,869	"
Brown Psychological	2	2,949	6,381	9,340	"

Group E—Scholastic Aptitude Tests

Name of Test	Number of Institutions Giving Test	Number of Students			Used for Sectioning
		Engineering	Non-Engr.	Total	
Advanced Silent Reading	6	108	566	1,374	Yes
Nelson H. S. English	2	900	—	900	"
Inglis Vocabulary	1	300	—	300	No
Minnesota Reading	1	450	—	450	"
Wrenn Study Habits	2	250	700	950	"
C. E. E. Board Math. Apt.	2	12,431	120	12,551	"
Otis S. A. Higher Form	1	175	1,039	1,214	"
Sones-Harry, H. S.	3	340	2,112	2,452	"
Columbia U. Res. Bu. Eng.	1	298	1,690	1,988	"
Carnegie H. S. Achievement	1	1,200	1,000	2,200	Yes
C. E. E. Board, Sch. Apt. Tests	3	4,498	0	4,498	"
Amer. Council Sch. Apt.	1	—	—	650	"

Group F—Strong's Vocational Interest Test

Name of Test	Number of Institutions Giving Test	Number of Students			Used for Sectioning
		Engineering	Non-Engr.	Total	
Strong's Vocational Interest Test	10	4,050	2,060	6,110	No

TABLE 2

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Physics—reported by Amer. Council on Education, as having given tests	34	—	—	—	—

Group C—Placement Tests in Subject Named, Constructed by and Used Locally in Individual Colleges

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Engineering Drawing	5	1,700	0	1,700	Yes
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Physics	3	600	0	1,200	1, yes
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TABLE 2—*Continued*

Group D—General Psychological Tests

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Group E—Scholastic Aptitude Tests

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Sones-Harry, H. S.	3	340	2,112	2,452	"
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Carnegie H. S. Achievement	1	1,200	1,000	2,200	Yes
C. E. E. Board, Sch. Apt. Tests	3	4,498	0	4,498	"
Amer. Council Sch. Apt.	1	—	—	650	"

Group F—Strong's Vocational Interest Test

Name of Test	Number of Institutions Giving Test	Number of Students			Used for Sectioning
		Engineering	Non-Engr.	Total	
Strong's Vocational Interest Test	10	4,050	2,060	6,110	No

TABLE 2—*Continued*

Group G—Special Engineering Aptitude Tests

Name of Test	Number of Institutions Giving Test	Number of Students			Used for Sectioning
		Engineering	Non-Engr.	Total	
Zyve Scientific Apt.	4	450	0	450	No
Mann Drawing Aptitude	3	1,600	0	1,600	Yes
Stenquist Mech. Apt.	2	120	0	120	No
Cooper Union Sc. Reading	1	7,558	0	7,558	—
Cooper Union Sc. Representation	1	415	0	415	—
Mann's C. E. Aptitude	1	170	0	170	No
Mann's Reading of Drawings	1	420	0	420	No
Wright's Draw. Achievement	1	300	0	300	Yes
Manhattan College Engr. Apt.	1	198	0	198	No
Minn. Form Board Rev.	1	900	0	900	No
Ore. A. & M. Engr. Motives	1	200	0	200	No

Group H—Tests of Visualization or Spatial Relationships

Name of Test	Number of Institutions Giving Test	Number of Students			Used for Sectioning
		Engineering	Non-Engr.	Total	
McCauley Tetrahedron	10	1,866	0	1,866	No
Mann Dynamic Cube	5	1,344	0	1,344	Yes
Mann Static Cube	4	550	0	550	No
Mann-Grant	2	616	0	616	Yes
Crawford's Yale	2	78	0	78	No
Cooper Union Spatial Rel.	1	8,751	0	8,751	—
O'Connor's Wiggly Block	2	78	0	78	No

To gain a clear perspective of what the colleges have set out to do, and of what the S. P. E. E. Committee on tests has sought to do since 1931, we desire to set forth the list of projects which S. P. E. E. suggested the colleges might engage in; and also the original program according to which our Committee sought to work, as follows:

Projects Suggested by S. P. E. E. to Engineering Colleges for Experimentation

(1) Development of tests of aptitude for engineering.
(2) Development and trial of selective tests as an adjunct to admission by certificate.
(3) Determination of the causes of failure and elimination.

(4) Development and trial of comprehensive examinations at the end of the sophomore year, to measure achievement and capacity for further progress.
(5) Development and trial of comprehensive examinations in the student's major branch as a qualification for graduation.
(6) Methods and results of sectioning on the basis of ability.
(7) Institution and trial methods of increasing the degree of self-direction in the work of the two upper years (*i.e.*, "honors courses")
    (*a*) Methods applicable to all students
    (*b*) Special programs for exceptional students.
(8) Institution and trial of a course in engineering economy based upon the case method of instruction.
(9) Institution and trial in the principal curricula of senior options in functional divisions of engineering.
(10) Institution and trial of a curriculum in two stages, with certificate at the completion of the first stage, and a degree at the completion of the second.
(11) Institution and trial of a post-scholastic stage of directed study.
(12) Institution and trial of specific training in the technique of teaching, by seminars or individual coaching.
(13) Institution of programs of graduate work particularly designed as a preparation for teaching.
(14) Institution of complementary fifth year devoted to a program in administration, for graduates.

Of the projects listed above, those numbered 1, 2, 3, 4, 5, 6, and 10 are the ones in which this committee has an especial interest. They indicate the line of work this committee set out to do.

The original agenda projected and approved by this Committee to guide it in a program extending over a number of years was presented at the Corvallis meeting, in 1933. Some most excellent achievement tests in algebra, trigonometry, descriptive geometry, general engineering drawing, English, chemistry, and the five main divisions of physics are now on the market; and those in physics being distributed by the Coöperative Test Service of American Council on Education should interest all teachers of physics. An excellent series of eight objective tests in physics have been prepared by Professor Lapp, of Iowa State University, and these may be secured from the Coöperative Test Service or the University of Iowa. Thus it appears that various agencies are gradually extending the list of tests our Committee desired to use. This only serves once again to emphasize the tremendous value of the experimental and research work being done in various departments of our engineering colleges. This committee desires to become acquainted with all such work, and to help secure its recognition. The Com-

mittee agenda is as follows. It may provide suggestions for use of interested engineering teachers and colleges who care to undertake such work:

AGENDA OF THE S. P. E. E. COMMITTEE ON TESTS AND COMPREHENSIVE EXAMINATIONS

I. ACHIEVEMENT TESTS. (Set up examination and correlate with course grades.)

A. Mathematics:
(1) Algebra
(2) Trigonometry
(3) Analytic Geometry
(4) Differential Calculus
(5) Integral Calculus
(6) Differential Equations, etc.

B. Drawing:
(1) Descriptive Geometry
(2) Gen. Eng. Drawing
(3) Machine Drawing
(4) Shades and Shadows
(5) Architectural Drawing, etc.

C. Chemistry:
(1) Inorganic
(2) Organic
(3) Qualitative Analysis
(4) Quantitative Analysis, etc.

D. Physics:
(1) Mechanics
(2) Heat
(3) Light
(4) Sound
(5) Electricity, etc.

E. English.

F., G., H., etc., other subjects in the core material of pre-engineering.

II. Study of pre-engineering curricula to determine the common content of such curricula. Study correlation of supposedly important subject grades with later success in professional portion of the curriculum.

III. Set up from I and II tentative pre-engineering comprehensives for trial in as large a number of engineering schools as possible.

IV. Study of professional portions of curricula and stated board examinations to determine the highly important core of material common to a large number of engineering schools.

V. Set up achievement tests in subjects found in IV.

VI. Construct comprehensive examinations covering the major engineering curricula, as civil engineering, electrical engineering (as has been done already at M. I. T. in electrical).

VIII. Construct various Special Engineering Aptitude Tests, find correlations both with technical study and with later engineering success.

A. Mechanical aptitude tests
B. Strong Vocational Interest Test
C. Achievement tests at the high school level
D. Iowa type Placement Tests
E. I.Q. tests (psychological tests in general)
F. (Walter's Tests.)
G. Mann's Tests of Visualizing Ability
H. Stenquist Test, etc.

Present Usage of Comprehensive Examinations

Comprehensive examinations in fields of study other than engineering are being constructed and widely used in colleges in this country. The Committee has in its display of tests at this session copies of such examinations in the subjects of History and Literature; History, Government and Economics; and Ancient and Modern Languages, published by Harvard University. These are but examples of many such tests in use.

Batteries of placement tests such as the Iowa and Coöperative Tests can be considered as comprehensive examinations covering the four years of high school work when all available tests in the several fields of study are used collectively as a unit. H. H. Armsby, in a paper entitled "A Ten Year Study of Placement Examinations," presented at our Committee Conference, has shown very decisively that such batteries of the Iowa Tests are very effective when used to select entering freshmen and to predict their chances of graduation after four years at Missouri School of Mines.

Lehigh University has since 1930 been using some very excellent comprehensive examinations designed to be given at the close of the sophomore year in the engineering college. They cover the first two years of standard engineering instruction, and are intended in part to determine fitness of students taking them for entrance upon the third and fourth years of engineering study. Geo. B. Thom, of Swarthmore College, in a paper entitled "Observations on the Predictive Value of Comprehensive Examinations," also read at our Committee Conference, has given us some very interesting, valuable data respecting use of these Lehigh examinations.

The Department of Electrical Engineering at Massachusetts Institute of Technology has for some years used their "Comprehensive Examinations for Honor Group Students." The Committee has samples of these tests in its display at this session. These examinations also call attention to the "honors student" program in that school. "Comprehensive Examinations for Sophomores and Seniors," by Dean Paul Cloke, University of Maine, is an interesting paper also read at our Committee Comference.

State-wide High School Testing Program

We can do no more than take note here of a type of examination the Committee had in mind in subdivisions II and VIII of the above agenda—namely, pre-engineering tests at the high school level. In all likelihood this type of test will be promulgated adequately by various colleges and state universities. Several of our state universities have already constructed batteries of such tests, in form much like the Coöperative and the Iowa Placement Tests, and have inaugurated state-wide "every pupil high school testing programs." The state universities of Iowa, Nebraska, and Wisconsin furnish examples, without including all that are doing this. The Iowa program includes objective tests in ninth year algebra, plane geometry, general science, biology, physics, world history, United States History, economics, American government, Latin, reading comprehension, English correctness, and contemporary affairs. The enormous effort being expended in this program will be realized when the total number of Iowa pupils tested the 1935–36 year is considered. The grand total of such tests administered during that year is 153,400.

Many states engaged in high school testing programs are now using the Ohio Psychological Test, Forms 17 and 18. These are given sometimes alone, as in Missouri; or often in conjunction with other high school content tests, as in Nebraska.

Some effort has been made to check up on results of such high school testing, to ascertain whether students high in the high school test program rank high in subsequent professional and college study. The studies made to date do not provide sufficient data for drawing satisfactory conclusions. Probably the engineering colleges will, in spite of such high school testing programs, want to administer their own freshman tests, because of the wide geographic distribution of entering students.

Necessity for a More Adequate Philosophical Basis for Testing of Engineering Aptitudes

The lack of an adequate philosophical concept of engineering aptitude appears still to be a great obstacle to measurement of engineering students. We have not gotten away from the idea on the one hand that the psychological test, *per se*, must be used in such programs. On the other hand, there are still those who think the engineer is "born, and not made," and that tests must show that the entering engineering freshman has some mystical "engineering aptitude" that students in other schools do not have. There needs to be formulated and stated as a basis for further testing by engineering colleges a scientifically sound, comprehensive notion of engineering aptitude.

As a beginning, it must be plain to all who think of it, that barring occasional notable exceptions, most of our engineers of to-day are, and most of tomorrow's engineers will be, college trained men. This being so, we can make a clear cut definition of the first essentials in engineering aptitude. *The student must have all those aptitudes necessary to enable him successfully to pursue four years of engineering study in the chosen line.*

On this simple and sensible basis, all the tests covering subject matter of pre-engineering courses, or of courses in the engineering curriculum, if designed to be given before the course is taken, become tests of engineering aptitude.

Again, we think that no single test, as a general psychological test, for example, will with any certainty demonstrate fitness for engineering study and practise. A complete, all around picture of the student is what is needed, and this is to be secured by administering not one, nor two tests, but many. And, so far as may be in keeping with practicality and judicious use of student time and college finance, the more tests given the clearer idea of the student's abilities will be obtained. These ideas are clearly brought out in the paper read by Professor Armsby, and a paper distributed in our conference by C. V. Mann, entitled "Systematic Selection and Guidance of Engineering Students." What is needed is a comprehensive scheme of differential measurement, based on a generous battery of aptitude tests, supplemented by such other measures of attitude, personality, character, financial means, parentage, interests, and other factors as can be constructed and scored by objective means.

Finally, some simple means of graphic representation of these measured qualities for the individual student needs to be devised and intensively used. There is no reason why the individual instructor should not have in his office sets of cards showing these properties of the students he teaches—provided he is determined to make a wise use of them. Students themselves can profit by studying their cards and having them explained to them. Personnel procedures confined solely to the office of a personnel staff are, in all likelihood, lacking in many desirable elements. The ideal personnel counselling system will take in also the engineering dean and interested engineering teachers.

Graphic records of individual students such as have been worked out by the American Council on Education, and also the "personograph" cards devised and used by C. V. Mann at Missouri School of Mines, are devices that merit much more attention and extended use.

A line of special aptitude testing that seems to be developing in a number of our engineering colleges contemplates measurement of

a quality much used in engineering design—the ability to visualize. A number of promising tests of this order have been constructed, and used in several engineering colleges, as Yale, Columbia, Ohio State, Arizona, Purdue universities; Rhode Island State College; and Missouri School of Mines. This program will be promulgated intensively through the Engineering Drawing Division of this Society.

W. H. TIMBIE, *Chairman*
J. W. BARKER,
JOHNSON O'CONNOR,
J. E. WALTERS,
BEN D. WOOD,
C. V. MANN (*Presenting Report*)

COMPREHENSIVE EXAMINATIONS IN THE COLLEGE OF TECHNOLOGY, UNIVERSITY OF MAINE

BY PAUL CLOKE
Dean of the College

Comprehensive examinations at the University of Maine had their genesis and origin with the introduction of the accumulative average plan for scholastic discipline. This plan was first introduced with the class of 1935, when they were freshmen, and gradually extended so that it was in full force four years later. Previous to the adoption of the plan, an extensive study was made of the point standing of graduates, during several preceding years, in the College of Technology. On the basis of their attainment, certain minimum averages were required at the end of successive semesters. An average of 1.7 was required for graduation on a basis of 4.0 as perfect.

Not long after the accumulative average plan was adopted at the University of Maine, a fall meeting of the New England Section of the Society was held at the University, at which time R. E. Doherty, then Dean of Engineering at Yale University, and Vannevar Bush, Dean and Vice-President of Massachusetts Institute of Technology, discussed and advocated comprehensive examinations. Their views on this subject have become well-known to the members of the society, so will not be reviewed here; also the work of Professor Richard H. Frazier, who has had charge of the comprehensive examinations in the department of Electrical Engineering at the Massachusetts Institute of Technology, has been followed with great interest by all engineering educators.

The section meeting, above referred to, gave considerable stimulus to the idea of comprehensive examinations and after a consider-

able discussion, it was decided to experiment with comprehensive examinations for sophomore and senior students in the College of Technology. These were given first in June 1933 and included *all* students in these two classes. In this respect they differed markedly from those given at the Massachusetts Institute of Technology, since there they are given to a selected group of students only. The purpose of the examinations also is different, I believe, as will be shortly evident. Many members of the staff had felt that the ordinary type of examination put major emphasis on memorizing and that logical reasoning and a knowledge of fundamentals did not have the place in the sun that they deserved. The Dean of the college had also observed that grade distribution among various members of the staff varied through rather a wide range for the same students. It was also felt that the comprehensive examination would call in a greater degree for independent thought and work on the part of the individual student and that, furthermore, it would place the emphasis where emphasis should be placed in any line of endeavor; that is in real achievement and accomplishment, rather than the obtaining of grades due to sudden spurts of action or intensive periods of preparation. In fact there are five major considerations which were discussed and studied before the present plan was adopted. It was believed:

1. That the comprehensive examination would put greater emphasis in the student's mind on a knowledge of fundamentals.
2. That it would teach him to reason from fundamental principles to logical conclusions.
3. That it would develop in him ability to correlate and organize knowledge in more than one field. In fact the examinations are comprehensive in the sense that they do call for knowledge in more than one field.
4. That it would minimize memorizing and emphasize the importance of reasoning.
5. The idea behind the whole movement including both the accumulative average plan and other regulations for scholastic discipline is guidance to the individual student.

Personally, the writer has seen entirely too many young engineers in middle life in mediocre positions due in some considerable degree, to the fact that they were not properly guided and oriented by their instructors and other faculty associates in their student days. The fact of the matter is that from the moment the student enters the College of Technology as a freshman, until he graduates, he is observed and instructed and counselled. This is particularly true during the freshman year, when our director of Technology freshman personnel, with a corps of assistant advisors, makes an intensive study of each student. The sophomore examination is aimed to

discover whether or not the student has a knowledge of fundamentals and to divert him away from stereotyped and memorizing methods of study and to find out whether or not he is prepared to go on with professional studies of the junior and senior years. The senior examination is designed to discover whether or not the student can reason from a knowledge of fundamentals to logical conclusions and also whether he can correlate and organize knowledge and an attack on a given problem from more than one field of knowledge. For example, a given problem in engineering might and usually does, involve a knowledge of economics, another problem might involve a knowledge of physics, chemistry and mathematics.

The examinations occupy two whole days. The sophomore examinations are in four parts, and are entirely written, half a day to each part. They are of increasing difficulty and perplexity and are designed to segregate students according to their initiative and originality, as well as knowledge. Consequently, the first part is comparatively easy and constitutes practically nothing more than a good examination in algebra, trigonometry, physics and chemistry, the latter problems involve calculus and the application of mathematics, physics and chemistry to some fairly intricate problem.

The senior examinations are much more definitely comprehensive in nature, in that the problem may run through the entire two days, one part depending upon another, such as a problem in design, heating and ventilating or power plants, or something of the sort, or electrical transmission lines and power plants, or possibly radio or communication problems. There is also a one hour oral examination.

The results of the sophomore comprehensives together with the two years' actual performance in the classrooms, are used as a guide in advising the student in regard to his future work and to determine his fitness to undertake the professional work of the junior and senior years. The senior comprehensive examinations must be passed to the satisfaction of the department in which the student majors.

On the basis of our experiment with these examinations, we have formulated certain regulations and rules for scholastic discipline which we feel will be of distinct aid to the student in determining whether or not he should aim to enter engineering as a profession. The first two years were very largely trial years. No particular use was made of the results. The senior comprehensives, however, were felt to be a success from the very beginning.

Lest someone might be led to the feeling that we feel that these examinations select students with infallible accuracy, let me say that we do not believe this. We certainly do know, however, that they segregate poor students from able ones and are of distinct aid to us in discovering at the end of the sophomore year, those students

who are not prepared to enter the professional work of the junior and senior years. Furthermore, let it be said with emphasis that this type of examination is of such a nature as to develop fundamental traits of good character, as honesty, self-reliance, fair dealing, and fundamental integrity of purpose.

A series of correlation studies have been made of the relationship existing between accumulative averages and comprehensive examinations for the classes of 1934, 1935, 1936. The following table gives the results of these studies:

So. aa = Sophomore accumulative average
So. C = Sophomore comprehensive
Sr. C = Senior comprehensive
Sr. aa = Senior accumulative average
aa 5S = Accumulative average for five semesters
R = Correlation coefficient

				R
Class	34	So. aa	Sr. C	.33
"	35	"	"	.46
"	36	"	"	.93
"	34	Sr. aa	Sr. C	.60
"	35	"	"	.67
"	36	"	"	.68
"	34	Sr. aa	So. aa	.93
"	35	"	"	
"	36	"	"	
"	36	So. C	Sr. aa	.59
"	36	"	Sr. C	.52
"	37	So. aa	aa 5S	.98
"	37	So. C	"	.75
"	38	So. aa	So. C	.77

It will be observed that the coefficient is high for correlation of accumulative averages. This fact, of course, has been known to engineering educators for several years. As experience was gained with the passing years the coefficient for the comprehensive examination becomes higher. This is a fact which is not necessarily desirable as the comprehensive examination may well, and I believe does measure factors which the ordinary procedure does not. As a matter of interest certain studies were completed on the classes of 1937 and 1938. These, of course, cannot be considered conclusive, or final.

Probably the best test of the success of the plans is to be found in the endorsement of the faculty. There is no doubt but that comprehensive examinations are a real and powerful educational tool, and that real progress is being made in how best to use them.

NEW MEMBERS

ADES, CLIFFORD S., Assistant Professor of Civil Engineering, The Citadel, Charleston, S. C. L. S. LeTellier, John Anderson.

AIKEN, CHARLES B., Associate Professor of Electrical Engineering, Purdue University, Lafayette, Ind. C. F. Harding, G. C. Blalock.

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ZIPPRODT, ROY R., Associate Professor of Civil Engineering, Columbia University, New York City. F. L. Eidmann, Bruce Johnston.

ANNOUNCEMENT OF SUMMER SURVEYING CONFERENCE

CAMP MARSTON, RANIER, MINNESOTA

July 25 to August 8, 1937

Preliminary reservations for the Summer Surveying Conference have been made in such gratifying numbers that definite plans were made at a Committee meeting in New York on January 21 and the following program was prepared.

The purpose of the course is to improve the teaching of surveying member institutions of the S. P. E. E. Each subject will be opened by a leader whose paper will serve as the background for the discussion during the period.

The entire program is designed to be suggestive of the many problems of the surveying teacher. It will be expanded by a special program committee, after the reservations have closed, to provide a place for each man in the discussions.

PROGRAM

July 25. Leave Ranier, Minnesota by boat for Camp—10:00 A.M. Arrive Camp Marston—2:00 P.M.

July 26. Outline Purpose of Conference. Improvement of Surveying Teaching.

July 27. The Content of the Surveying Course for Civil Engineers.

July 28. Methods of Teaching and Assigning Work. Job Method versus Component Method.

July 29. Aerial Surveying Instruction.

July 30. Plane Coördinates and Geodetic Control. Practical astronomy and Cadastral Surveys.

July 31. Content of the Surveying Course for Non-Civil Engineers.

August 1. Sunday—Devotions, Excursions.

August 2. Surveying Instruments from the Maker and User Standpoint. (All makers invited.)

August 3. Instruments for Student Use—Custody, Student Responsibility, Repairs, Maintenance.

August 4. Relation to the Profession—The Land Surveyor.

August 5. Field Notes—Checking Results. Need for Surveying Knowledge by Graduates.

August 6. Summer Camps.
August 7. Break Camp. Leave for Ranier—8:00 A.M. Arrive Ranier—12:00 Noon.

Campfire programs will be arranged for alternate evenings.

Space does not permit the inclusion of the names of leaders here. The committee will mail a tentative outline of speakers and will invite each man who attends to prepare a definite part of the program. A list of those who register for the conference will be mailed so that automobile parties may be made up if desired.

Some teachers are planning to take the lake trip to Duluth from Buffalo or Cleveland. Others will go by train or bus. Many will drive. At least one will bring his trailer. Autos and trailers must be stored in Ranier, which is the embarkation point. Complete instructions are being mimeographed for mailing to prospective members of the Conference. Much additional information regarding the Camp and the Conference was published in the December Civil Engineering Division Bulletin.

The Committee has preliminary reservations from Surveying teachers representing the following universities: Akron, Alberta, Arizona, Columbia, Cornell, Hawaii, Illinois, New York, North Dakota, Princeton, Rutgers, South Carolina, Syracuse, Utah, and Wisconsin; and the following colleges: Cooper Union, Lafayette, Iowa State, Manhattan, Missouri School of Mines, Oklahoma A. & M., Rensselaer, Washington State; also from instrument makers, Burger Co., Buff & Buff, Keuffel & Esser, and W. & L. E. Gurley; and mapping agencies as follows: Bureau of Public Roads, U. S. Coast and Geodetic Survey, General Land Office, Geological Survey, Lake Survey, Minnesota State Highway Department, Duluth City Engineer.

Other Institutions showing interest are: Massachusetts Institute of Technology, Tufts College, Gettysburg College, University of Vermont, Massachusetts State, University of Pittsburgh, University of Dayton, Penn State, Clemson College, University of Nebraska, University of Virginia, University of Florida, Worcester Poly, Ohio State University, Michigan State College, University of Minnesota.

Correspondence should be addressed to J. S. Dodds, Box 207, Ames, Iowa, Chairman of Sub-Committee on Summer Surveying Conference.

The T-SQUARE PAGE

DEVOTED TO THE INTERESTS OF THE DIVISION OF ENGINEERING DRAWING

FRANK A. HEACOCK, EDITOR

Technical Sketching.—When an engineer wishes to express an idea or convey technical information to others, he often finds that words are inadequate and that he must make a freehand sketch to illustrate and clarify his explanation. So the technical sketch has become an indispensable aid to engineers. It has a universal appeal, because it is the only language that everyone understands. Most people prefer to look at pictures, and the sketch like a picture tells its story at a glance. Technical sketching is the mode of expression in constant use by executives, designers, and the rank and file of engineers everywhere.

Facility in freehand sketching affords a most effective means of conveying detailed information to others. Instructions to draftsmen and mechanics, conferences with associates, reports to executives, sales talks, directions for installing and operating equipment—all call for technical sketches which save hours of verbal explanation. Many engineers find that the ability to make quick, effective sketches is of greater value to them than drafting skill.

Facility in sketching is also a valuable aid to constructive thinking. Whenever an ingenious idea presents itself to the mind, it is advisable to record it on paper in the form of freehand sketch. The sketch amplifies the idea, revealing its possibilities and limitations. It serves as a guide for modifying the idea in order to improve its workability. Thus it clarifies successive steps in design. When reading a complicated drawing a rapid, pictorial sketch often helps in visualizing the details and their relation to each other. The sketch is a useful guide when making calculations, for it keeps the work orderly, gives better understanding of the parts referred to, and prevents mistakes of omission and overlapping. In many ways the sketch proves its value as a means of self-help in mental work of various kinds.

Facility in technical sketching does not require artistic talent. It is the result of intelligent practice and thorough training in the fundamentals of engineering drawing. It represents the mastery of the drawing language. It is the expression of clear, orderly

thinking based on exact knowledge and reinforced by good judgment in the choice of views, sections, and pictorial methods. Skill in freehand sketching is a valuable asset to anyone engaged in engineering work.

Drawing Instruments—Instruments of Education.—A certain instructor being asked, "What is the most important piece of equipment in the freshman's drawing kit?" replied, "The eraser, for it gives the student the chance to try, to weigh the result, and reject all or part of it and try again."

The thinking process in any field of study is not a direct forward movement toward the solution of a problem, but rather a series of efforts consisting of a plan set up, then tried and rejected or modified and tried again and again, until finally a tested and verified solution is found. The course then from problem to answer, in retrospect, appears as a straight line, but along the way lie many obliterated efforts to one side or the other of the true course. In drawing the eraser gives the student the chance to try his ideas and then reject, modify or correct them. The first effort need never be accepted so long as there is the will to improve. For in drawing, as in any art, a solution while correct may still be far from the best one possible.

Thinking in the drawing room, while in many respects quite elementary, nevertheless provides fine opportunities for the development of judgment and discrimination. The first location of a note on a drawing is not always the best especially in the light of work which may be done subsequently on the drawing. The first lettering of a two or three line legend is not always well balanced, but if the student is learning to reject the false and incorrect, to choose the good from the bad, to discriminate between the best and the acceptable, his eraser gives him that chance.

But we may rob him of his chance for real development if every drawing problem is completely charted and every view located, for the attempt to think must involve mistakes. These mistakes are valuable when they develop the power to see the error and reject it with the eraser and so move on not only to a better solution of a drawing problem but a better judgment, a finer discrimination and a will to exercise them.—Contributed by Prof. R. P. Hoelscher, Univ. of Illinois.

Drawings for the National Drawing Competition for 1937 of the Drawing Division will be exhibited at Cambridge, Mass., in June, 1937. For specifications and entry numbers write to Carl L. Svensen, Box 933, Lubbock, Texas.

ENGLISH NOTES

DEVOTED TO THE INTERESTS OF TEACHERS OF ENGLISH IN ENGINEERING SCHOOLS

J. L. VAUGHAN, EDITOR

Not very many years ago the great question concerning English was how important a place it should have in engineering education —perhaps even whether it should have any place at all. Happily, this question is no longer before us; it is perfectly accurate to say that the battle of the place of English in the curriculum has been fought and won. If there is any one problem concerning engineering education on which all are agreed—practicing engineers, administrators, and teachers—it is that English should occupy a place of major importance in our work.

The problem of the time allotment for English seems also to be well along the way to solution: in a majority of engineering colleges the study of English now extends through the first two years with a time allotment of from 8 to 12 semester hours. While few believe that this is all the time that instruction in English deserves, it seems on the average to be about as much as can be provided in the four-year undergraduate curricula without sacrifice of other elements of equally basic importance.

To say that all the problems of instruction in English have thus been solved, however, is very far from the truth. The question of the balance between time and emphasis devoted to composition, speech and literature alone is one to which almost endless discussion can profitably be given. In this connection I venture to express my own opinion, which must be recognized, of course, as that of a mere layman so far as instruction in English is concerned, that the teaching of literature is not only valuable in itself in broadening the horizon and developing the cultural interests of engineering students, but also that it possesses great merit as a medium for the development of the art of writing—much greater merit than is sometimes admitted. Were it not for the necessity of training inadequately prepared entering students in the routine mechanics of writing, I venture to say that all except a small remainder (for

work in speech) of the time devoted to English should be given to the study of literature.

No section of the Society has enlisted the interest and the support of all its members more than has the Committee on English. This is in part undoubtedly a recognition of the importance of the problems which the Committee considers, and it is also in no small part an indication of the continued vitality of the work of the Committee. The new page "English Notes" in the JOURNAL provides an opportunity for the continued discussion of the problems of English instruction, such as the one mentioned above. It will be looked with for interest each month by our members.

H. P. HAMMOND

AN UNFILLED NEED IN LITERATURE

My association with engineering society publications has been so intimate and of such long standing that I have no fear of a dearth of engineering literature. Much work of a high and useful order is being done, and our engineering societies are affording opportunities for making the best of it a part of the permanent literature. However, our needs lie in other directions; and teachers of English in engineering schools can be helpful in inspiring talented young men to enter, when their talents are ripe, this neglected field.

The times are calling dramatically to our attention the misconceptions that a surprising number of otherwise intelligent persons hold regarding what is popularly called our machine civilization. Alas, the number of engineers who can and do write acceptably for this audience, or who ever think of attempting to reach it, is pitifully small. Those who should be interpreting the engineer's concept of his function, his work, and the relationship they both bear to the lives of other men seldom enter the field of writing for the public. Nor have many engineers made serious efforts to formulate and teach a sound philosophy worthy of widespread consideration by the public. Only the scientists, with a few exceptions, have any considerable following among those who form their opinions from the writings of men close to the everyday work of the world. This is to be deplored.

The task of making contributions to literature of this type is not easy. It calls not only for the gift of easy and agreeable writing, but also for experience and an understanding of the subject matter—a rare combination, and one which few engineers have cultivated.

The avenues of approach are numerous. History, biography, expository essays, interpretations of engineering thought and phi-

losophy, and that medium so easy to mishandle, popular articles of broad appeal, instantly suggest themselves. In all of these work has been done—some of it quite creditable. But the great writer is yet to appear.

Two other media, the drama and the novel, are so rich in possibilities, that the wonder is that they have not been more frequently attempted by gifted engineers. Yet, when the engineer shall appear who will write the great drama of engineering civilization, or the great novel, his influence will be widely felt in all classes of society.

Notable examples of drama and the novel dealing with industrial society can be named—mostly the work of persons not too sympathetic with their subject matter—protestant literature depicting the seamy side of social conflict. To these may be added proletarian plays and novels, thinly disguising the propaganda of political unrest.

But the great novel, the great play—or even the reasonably good novel or play—where is it?

Engineering is young, but engineers are not the least intelligent, gifted, or critical of mortals. Some day the engineering profession will produce more men who can use these literary media successfully. Is it too much to hope that more inspiration and better methods in the teaching of English to engineering students may assist in developing latent talents?

GEO. A. STETSON, *Editor*
Mechanical Engineering

SECTIONS AND BRANCHES

The third annual meeting of the **Illinois-Indiana** Section will be held Saturday, April 3, 1937, at Urbana, Illinois. The program will be as follows:

Theme: Quality Rather Than Quantity in Engineering Education.

Morning Session:

Address of Welcome, Dean M. L. Enger, University of Illinois.

"What the Recognition Policy of the A. M. A. Has Done for Medical Schools," Dean D. J. Davis, University of Illinois College of Medicine.

"What the Accrediting of Engineering Colleges May Mean to the Engineering Profession," D. B. Steinman, Consulting Engineer, New York.

"Policies of the Accrediting Committee of the E. C. P. D.," Dean A. A. Potter, Purdue University.

At the noon luncheon:

"Is Engineering a Profession?" President A. C. Willard, University of Illinois.

Afternoon group conferences: Chemical Engineering, Civil Engineering, Economics for Engineers, Electrical Engineering, English, Engineering Drawing, Mechanics, Mathematics, Mechanical Engineering, Physics, Shop Laboratories.

The following excerpt from the minutes of the business meeting of the **Iowa-Wisconsin** Section of S. P. E. E. held at Ames, Iowa, on November 7, 1936, is quoted to inform you of the change in name of the Section which was recommended by the Resolutions Committee and adopted at the meeting.

"Be It Resolved

"1. That the name of this Section of the S. P. E. E. be changed from the 'Iowa-Wisconsin' Section to the 'North-Midwest' Section."

You may also be interested to know that the officers of the "North-Midwest" Section elected for the year 1937 are as follows:

President—F. A. Kartak, Dean of Engineering, Marquette Univ.

Vice-President—G. W. Swenson, Chairman, Dept. of Electrical Engineering, Michigan College of Mining and Technology.

Secretary—H. D. Orth, Chairman, Dept. of Drawing, University of Wisconsin.

Members of Executive Committee—

M. P. Cleghorn, Professor in charge of Mechanical Engineering, Iowa State College.

H. E. Wessman, Assoc. Professor of Structural Engineering, State University of Iowa.

H. D. Orth,
Secretary

COLLEGE NOTES

Iowa State College.—V. P. Hessler, E. E. Department, spent the summer with the General Electric Company continuing his investigation on electrical brush wear. Frank D. Paine represented the State of Iowa, and J. B. Davidson and M. P. Cleghorn represented the College at the Third World Power Conference at Washington, D. C., September 7–12. W. A. Bevan, Lt. Col. Air Res., was on active duty with the Material Division, Army Air Corps, Wright Field, Dayton, Ohio, August 30 to September 12. George C. Ernst, T. & A. M. Department, has accepted a position in the C. E. Department, University of Maryland. V. P. Jensen, T. & A. M. Department, is on a year's leave of absence at the University of Illinois to serve as mathematical analyst on a coöperative highway bridge slab investigation being conducted by the Bureau of Public Roads, the Illinois State Highway Department, and the T. & A. M. Department at the University of Illinois. R. G. Paustian, C. E. Department, is serving half time as a consultant on an aerial survey of land in eleven Iowa counties for the Iowa Board of Conservation.

The George S. Bartlett Award was conferred upon Dean Thomas R. Agg on November 19, 1936, at Washington, D. C. This award is conferred annually on the individual who has made an outstanding contribution to highway progress. The Board of Award consists of the following organizations: The American Association of State Highway Officials, the American Road Builders Association, and the Highway Research Board. Senior Dean Anson Marston presented Dean Thomas R. Agg for the reward. Since it was necessary for Dean Agg to be in Houston, Texas, to attend and deliver an address at the annual meeting of the American Association of Land Grant Colleges and Universities on November 19, the award was received in proxy by Professor Ralph Moyer of Iowa State College for Dean Agg.

New Members of the Staff: John F. Calvert, Associate Professor in Electrical Engineering; Lewis M. Headley, Associate Professor in Mechanical Engineering; Ben Whisler, Instructor in Civil Engineering; Stephen J. Chamberlin, Archie Higdon, and J. Stuart Johnson, Instructors in Theoretical and Applied Mechanics; William B. Stiles, Instructor in Theoretical and Applied Mechanics, transferred from General Engineering Department; Lawrence Hillyard and E. H. Ohlsen, Instructors in General Engineering.

The following graduate assistants and research fellows have been promoted to instructors: Richard E. Benson and G. L. Bridger, Chemical Engineering; Warren B. Boast, Electrical Engineering; Kyle Engler, Agricultural Engineering.

Additions to Plant and Equipment: The Electrical Engineering Department has installed a device for demonstrating the application of the photo-electric cell for the sorting of manufactured products, raw materials or fruits.

The old Aeronautical Laboratory has been turned over to the college band. The old Pattern Shop has been remodelled into a new Aeronautical Laboratory. The building now includes an office, equipment room, and engine test room. Both air-cooled and liquid-cooled engines can be installed on the universal torque stand for Department of Commerce reliability and performance tests. A new adjustable pitch Hamilton metal propeller has been installed on the LeBlond "60" engine now on the torque stand.

The Theoretical and Applied Mechanics Department has recently purchased a 100,000 pound Universal testing machine and a 10,000 inch pounds torsional testing machine.

A new three story addition to the Mechanical Engineering laboratory has just been completed at a cost of $40,000, and approximately $10,000 worth of new equipment added. In the building are class rooms and modern laboratories for heat treatment of metals, metal casting, gas and electric welding, and for study and analysis of metal cutting processes.

Research and Development: The research in the use and suitability of Iowa coal in underfeed domestic stokers is being continued in the Mechanical Laboratory.

A new research on the use of Iowa sands for foundry purposes has been started by the Engineering Experiment Station under Mechanical Engineering supervision.

The following projects are being carried on by the Ceramic Engineering Department under the direction of Professor Cox:

Project 202. The development of suitable clay blends so that production of relatively thermal shock resistant chimney liners may be produced. This research is sponsored by the Clay Products Association of the Mid-west. In addition, work will be done on jointing cements to provide a jointing cement which will not deteriorate under heat in a chimney and also another type which will not deteriorate under the action of sewage acids.

Project 188. The application of the fundamental principles concerning heat transfer from water vapor and carbon dioxide in a study of the effect of exaggerated quantities of the two gases in burning clay wares. This is the first study of this sort ever

attempted. It has been established that clay wares mature at least 100 degrees C. lower under such conditions. It is known that water vapor is not good for glazed wares. The work is being done primarily to produce building materials at lower temperatures, with the resulting fuel economies.

The Agricultural Engineering Department has built a basin lister for controlling run-off, a rotary terracer for filling terraces, and a dynamometer for horse pulling contests.

Student research problems, laboratory organization and the instruction methods employed by the **Johns Hopkins School of Engineering** will be demonstrated at the three-day celebration of the School's twenty-fifth anniversary on February 19, 20 and 22. Extensive exhibits representing important engineering problems and technical sessions in which leading engineers from academic, industrial and public circles will participate, are additional features of the anniversary program.

The outstanding event of the program will be the address delivered at the sixty-first Commemoration Day exercises of the University on February 22 by Karl T. Compton, president of the Massachusetts Institute of Technology, and a member of the Society for the Promotion of Engineering Education.

Papers on the respective technical investigations engaging the interest of the heads of departments in the School are to be read during the conference period on the morning of the 20th. These are intended to show the type of research activity that is now being applied to advanced problems.

Closely associated with the themes of these papers will be the major groupings of the objects on exhibition. Experiments on oil insulation and high frequency voltage, and the effect of lightning on power transmission lines; structural welding, the determination of stresses and deflections on a new type of bridge foundation; sanitary engineering equipment and the apparatus used in various gas analysis are but a few of an extended list of scientific displays now being prepared.

The short history of the School has been distinguished by many important contributions to the methods and materials of engineering analysis. The high quality in research and the advanced instruction that gave the University its unique place among institutions of higher learning became a part of the background and standards of the Engineering School. Its talented faculty has as its dean J. B. Whitehead, first professor of electrical engineering, a position which he has held for the intervening quarter-century. Associated with him at the School's founding were Carl Clapp

Thomas, professor of mechanical engineering and now vice-president of the Dwight P. Robinson Company, and Charles J. Tilden, first professor of civil engineering and now professor of engineering mechanics at the Sheffield Scientific School of Yale.

Kansas State College has experienced more changes in its faculty personnel in the Engineering Division during the past year than for several years. These changes have been due to leaves of absence, resignations, and creation of new positions.

In the Department of Applied Mechanics, Assistant Professor Gerald Pickett was granted a year's leave of absence to do advanced work at the University of Michigan. Two graduate research assistants are employed in that department: Mr. R. F. Adams, who is working on a fellowship paid by the Dewey & Almy Chemical Company for research in cement, and Mr. Elmer Munger who will do research in concrete.

Professor L. C. Paslay, of the Department of Electrical Engineering, resigned last August to take a position with the National Geophysical Company at Dallas, Texas. His position was taken by Mr. M. W. Horrell, temporary instructor, who came from the First National Television, Inc., of Kansas City, and has been placed in charge of the college television station W9XAK. Two graduate research assistants in this department are Mr. Earl B. Ankenman, who is working on the wind-electric Engineering Experiment Station project, and Mr. C. F. Crandell, who is assisting in research work in television.

In the Department of Mechanical Engineering, Assistant Professor A. O. Flinner is on sabbatical leave doing graduate work at the Massachusetts Institute of Technology. Mr. A. J. Churchill resigned to accept a position with the Westinghouse Electric & Mfg. Company. Mr. Wilson Tripp, a graduate of the University of California, has been employed as instructor in that department, and Mr. E. L. Broghamer is temporary instructor. Mr. L. C. Burkes is a graduate assistant doing research work in that department.

Professor C. E. Pearce, Head of the Department of Machine Design, is on a leave of absence for advanced study at Cornell University. Professor F. A. Smutz is acting head during his absence. Mr. J. L. Brubaker, instructor in that department, resigned to go with the Western Electric Company at Chicago. Mr. F. J. Norman, from Iowa State College, and Mr. J. N. Wood, from the State University of Iowa, have been employed as instructors in that department.

In the Shop Practice Department, Associate Professor Eugene Graham passed away last year. His place has been filled by Asso-

attempted. It has been established that clay wares mature at least 100 degrees C. lower under such conditions. It is known that water vapor is not good for glazed wares. The work is being done primarily to produce building materials at lower temperatures, with the resulting fuel economies.

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ciate Professor M. R. Wilson who comes with several years teaching experience in vocational education. Assistant Professor H. W. Aiman, who was absent last year due to ill health, is on duty this year. Mr. L. A. Moore, graduate assistant, is doing research work on arc welding for the department.

Massachusetts Institute of Technology.—Development of a mathematical machine capable of solving nine simultaneous linear algebraic equations involving nine unknowns has been designed and built by Dr. John B. Wilbur of the department of Civil Engineering. The new machine is part of the broad program under way at the Institute for the mechanical solution of mathematical problems which baffle and delay progress in engineering and research.

During the three years in which the machine has been under development, Dr. Wilbur has had the close coöperation of Dr. Vannevar Bush, Dean of Engineering, whose own contributions in the field of mechanical solution of mathematical problems have received wide recognition.

Equations of the type solved by the new machine, which is known as the simultaneous calculator, constantly occur in engineering and scientific analyses covering a wide range of fields. Designed originally for the solution of problems in civil engineering, such as complex calculations that arise in the design of skyscrapers, the calculator promises to be useful in such diverse fields as nuclear physics, geodetic surveying, genetics, and psychology. For the mathematician it is a new tool for the evaluation of determinants.

Once the coefficients and constants of the particular equations to be solved are set up on the new calculator, a single movement of the mechanism accomplishes mechanically in a few seconds mathematical processes which might take days if carried out by the usual methods.

The simultaneous calculator, which weighs 2,000 pounds and has more than 13,000 separate parts, including six hundred feet of flexible steel tape and nearly a thousand ball-bearing pulleys, is the outgrowth of an experimental laboratory model built by Dr. Wilbur in 1934. The new machine has undergone exhaustive tests and is now in active operation. Construction of the calculator was made possible by a fund established by Sir Douglas Alexander of New York.

Charles E. McQuigg, New York City, will become dean of **Ohio State University's** college of engineering July 1.

In its selection, the University has recalled one of its own alumni

to the campus. Mr. McQuigg graduated in 1909 with the degree engineer of mines. Since 1934 the dean-elect has been director of research for the Union Carbide and Carbon Company in Long Island City. His previous experience has included both industrial work and teaching.

Following his graduation from Ohio State, Mr. McQuigg was with the Santa Fe railroad for a year, going then to the Anaconda Copper Company in Montana. In the latter position, as assistant engineer of tests, he devoted his attention to ore concentration, the blast furnace, smelting and refining. Then followed five years as head of the department of metallurgy at Pennsylvania State College.

During the World War he was a captain in the U. S. Army ordnance department, with responsibility for inspection and acceptance of all materials for the small arms program. For two years following he was with the research and development laboratories of the Electro-Metallurgical Company at Niagara. Since 1921 he has been with Union Carbon and Carbide, advancing steadily through the research and development departments of that organization.

Dean Embury A. Hitchcock retired as head of the engineering college at Ohio State last summer. Since that time the college has been administered by William D. Turnbull as acting dean. Mr. Turnbull had previously been junior dean of the college.

Rensselaer Polytechnic Institute.—Research into the electrical sources of life is under way here with the aid of a grant of $5,000 from the Rockefeller Foundation. The work is under the direction of Orlan McGrew Arnold of the department of chemical engineering and chemistry, who is prying into the structure and behavior of protein molecules from a new approach. He is using radio type generators of high frequencies, with sensitive detectors and special amplifiers. From the reaction or behavior of the molecules to the electrical currents to which Dr. Arnold subjects them, he hopes to enlarge existing knowledge as to their structure. "Within the cells of our bodies," he says, "we know that protein molecules play the major roles. But how? What goes on in the cellular structures, of which the complex molecules are parts and of which all organisms are composed?"

Do people drink themselves into insanity more because of inherited or racial tendencies, or more because of conditions of environment? That is the question which Simour D. Pomrinse, senior in biology, is trying to answer in his thesis. Engineering enters the matter, for part of Pomrinse's thesis has to do with the

ratio of alcoholic insanity in crowded housing areas to the ratio in better planned areas where homes and offices are better constructed.

William Pitt Mason, who retired in 1925 as head of the department of chemical engineering and chemistry, died January 25 at his country home in Little Boar's Head, New Hampshire. He was 83 and one of the country's pioneers in sanitary engineering, particularly as it applied to municipal water supplies. He had served as consultant to many cities. Dr. Mason began his teaching career with Rensselaer in 1875.

NEW COMMITTEES APPOINTED

Advisory Committee to Committee on Engineering Economy in relation to operation of the Summer Session: A. R. Cullimore, D. S. Kimball, R. A. Seaton, P. T. Norton, Jr., O. W. Eshbach.

Technical Institutes: Walter B. Russell, Chairman, John A. Randall, John T. Faig, Frederic H. Sexton, Fred B. Wheeler.

Manufacturing Processes: Ralph M. Barnes, Chairman, C. A. Koepke, R. L. Sweigert.

Note: In order that Dean B. M. Brigman, University of Louisville, may devote his entire energies to rehabilitation of Louisville, he has been relieved of his duties as Chairman of the Committee on Mechanical Engineering. F. L. Eidmann, Columbia University, has kindly consented to act as Chairman of that Committee.

NECROLOGY

JOHN NICHOLAS VROOMAN VEDDER, professor of thermodynamics at Union College, died suddenly at the age of 63.

Professor Vedder was born in Niskayuna November 28, 1873, the son of Abram Vedder and Mary Vrooman Vedder, Holland Dutch stock which settled in the Mohawk valley in the 17th century.

He was prepared for college at Union Classical Institute and was graduated from Union College with an A.B. degree in the class of 1895. He studied at Columbia University, majoring in mathematics and mechanics, and after teaching at Stevens Institute of Technology he was employed at the American Locomotive Company in the calculating department. He left that post to take the position of research assistant in the department of electrical engineering at the University of Illinois. He returned to his alma mater as assistant professor of thermodynamics in 1914. He was promoted to the associate professorship in 1918, and to a full professorship in 1931.

BOOK REVIEWS

Electrical Laboratory Experiments, arranged and revised by BOYD C. DENNISON, Professor of Electrical Engineering, Carnegie Institute of Technology. John Wiley and Sons, Inc. 487 pages. $4.00.

The book is an abridgment of the two volumes of "Experimental Electrical Engineering" by Vladimer Karopetoff. The author states that he was guided in choosing the subject matter from the above volumes by answers to a questionnaire sent to some fifty teachers of Electrical Engineering. The result is a volume which contains the select material of the older volumes together with many new illustrations and curves.

The teacher of Electrical Engineering Laboratory will find in this volume a manual which covers most of the essential technique in this field. Such subjects as electrical measurements, magnetic circuits, instruments, direct and alternating circuits and machinery are treated extensively enough to provide ample material for a number of undergraduate courses. Reference for further reading in current literature is provided at the end of each chapter. A part of the chapters are given over to theory which precedes specific direction for experimental procedure. All diagrams, curves or illustrations are consecutively numbered. The book also contains an adequate index.

From a physical standpoint, the book is well bound, is easily read, is not bulky and is of attractive appearance.

It is the reviewer's opinion that the abridgment fulfills the needs of the average undergraduate course of laboratory work. In certain cases it could also be used as a textbook.

R. W. AHLQUIST

Lessons and Problems in Electricity. By N. C. PAGE. Published by MacMillan Co. 356 pages. $2.75.

Professor Page has, as he suggests in his preface, produced a book which emphasizes principles rather than applications. Physical principles treated mathematically and thoroughly are emphasized throughout the entire book.

There are thirty chapters with a generous list of problems at the conclusion of each chapter. Fundamental electrical and physical laws including magnetism, thermo-electricity, condensers, induc-

tance, gaseous conduction, alternating current power, three-phase circuits, electrical oscillations and electromagnetic radiation are treated in this book.

I agree with the author that there are some few institutions where mechanics and calculus are given during the Freshman year. However, in general such training is given in the Sophomore year. For this reason the book will probably receive a wider adoption for use with Junior electrical engineers and science students who wish to get principles with an engineering flavor, rather than with Sophomore students.

This book is certainly a worthwile contribution to literature in the field of a mathematical treatment of physical and electrical phenomena.

R. C. GORHAM

Thermodynamic Properties of Steam. By J. H. KEENAN AND F. G. KEYS. Published by John Wiley and Sons, Inc.

Although the word "table" is not present in the title, a little thought by an engineer will reveal it. The book, or set of tables, is unique in that the theory involved is explained in the introduction. The very definite international agreement on Joules equivalent necessitated a revision of earlier Kennans Steam Tables. This upset in our present conception of a B. T. U. will take some time to "sink in" but it is the only real remedy to the past state of international confusion.

The extension of the steam tables to a pressure of 5,500 lb./sq. in. and a temperature of 1600° F. will prove valuable. Naturally enough, this extension involves only the superheated vapor table.

The title itself is really incomplete, for the book includes tables on compressed liquid and solid-vapor. Very brief tables of viscosity and heat conductivity are included.

Due to international agreement on the Joule equivalent, the high pressure and temperature properties are quite different from the previous tables.

STEPHEN J. TRACY

Principles of Electric and Magnetic Measurements. By P. VIGOUREUX AND C. E. WEBB, of the National Physical Laboratory. Prentice-Hall, Inc. 392 pages. $5.00.

The authors of this book state it is "intended to acquaint students of physics or electrical engineering with the principles and practice of experimental electricity and magnetism. It is believed that it can also prove useful to the research student, not so much in giving him elaborate details of technique, but rather in helping him to grasp the general principles underlying measurements."

The book is divided into parts dealing with the general topics of electricity and magnetism. The chapters divide the material covered in such a way that practically each deal with the theory and measurement of distinct phenomena. As an example, Chapter II deals with the action between electric charges and describes the instruments used with this particular phenomenon, such as the torsion balance; the electroscope; disc quadrant and string electrometers; and electrostatic instruments. The chapter headings include: Units and Standards; Magnets and Currents in Magnetic Fields; Heating Action of Currents; The Potentiometer; Network of Conductors; Electrolysis; Electro-Magnetic Induction; The Thermionic Tube; Measurements at Radio Frequencies; Electric Charges in Electric and Magnetic Fields; Magnetic Measurements; Magnetic Measurements (continued).

Under the chapter on Magnets and Current in Magnetic Fields, about twenty instruments or devices are described dealing with this phenomenon. Similar treatment is found for networks of conductors, which deals with a variety of direct and alternating current bridges. In considering Electric Charges in Electric and Magnetic Fields the authors include the cathode ray oscillograph, x-rays, ratio of e/M for cathode particles and positive ions. Characteristics of thermionic tubes and their applications as rectifiers, amplifiers and generators are given. Under Magnetic Measurements is found descriptions of a variety of methods for measurements for magnetic properties of materials including the ferro, para, and dia-magnetic substances. "Magnetostrictive effects" are described and methods are outlined for obtaining and measuring them.

The topics are presented clearly and in a logical order. Where it is desirable the authors use mathematics, but not so that it becomes burdensome. This book is one of the most comprehensive in this field and merits the consideration of instructors and others interested in the field of measurements.

ROBERT W. AHLQUIST

Engineering Drawing Sheets. Series B. By THOMAS E. FRENCH AND H. M. MCCULLY. McGraw-Hill Published Co.

Series B repeats the ability of Series A of the "Engineering Drawing Sheets" by the same authors to put "life" into the drawing course. The ample material provides the instructor with easy choice of assignments adaptable to courses of various lengths and purposes. The outlined course should prove helpful to an inexperienced teacher as the authors' purpose behind each exercise is clearly stated. The ample material readily lends itself to the

methods of a teacher who has developed his own procedure and technique. The orderly development of each division of the course from its simplest beginning is impressive. For instance, the relation between detail and assembly drawing is developed by successive exercises in identification of parts, composition of a Bill of Material, appropriate lettering, assembly from sketched details, details from an assembly, and checking and correcting errors in technique and dimensioning.

The material gives the student a sense of the reality by its relation to conditions that he can visualize as occurring in actual engineering practice, and the modern student is inclined to insist on such a presentation. He is made acquainted with drawing-room methods and procedure, as on page 54 it is stated that a Bill of Material in structural detailing is typed on bond size paper. The ambitious student should be stimulated to further study of structural detailing, architectural drawing, and the reading of topographical maps by interesting exercises introducing problems an engineer in any field might encounter.

Exercises on interpreting and plotting graphs on rectilinear, logarithmic, trilinear and polar coördinate paper testify to the thoroughness of the outlined course.

A. C. EDGECOMBE

G-E *Campus News*

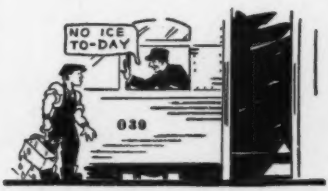
TURBINE STEEL CREEPS

IF the wrong kind of steels were used in turbine construction, the machine would not go creeping across the floor with the operator in hot pursuit, but the results might be even more disastrous.

Part of the increase in efficiency that has come about in the power-generating field in the last few years has been due to increased steam temperatures and pressures. As a result, the modern turbine shell runs, almost literally, red hot. This shell must withstand pressures such as exist half a mile down in the ocean and must keep a 20-ton rotor spinning perfectly in line. Heat softens metal, just as it softens candy, and permits it to stretch. This stretch, however, must be kept to the merest creep—about one part in 1000, if the changes are uniform.

In the Schenectady Works turbine shop, automatic electric furnaces hold samples of turbine steel at the temperature which will occur in the turbine. Gauges, which indicate changes of one part in a million, measure the creep as the pieces are exposed to heat for years at a time. From these tests, the best steel is selected.

It has been largely due to this research carried on by General Electric that the temperature and pressure of steam used in power generation have been raised to unexpected highs in the last few years.



ICE WATER

NEW electric drinking-water coolers introduced by General Electric have replaced the antiquated ice-cooled type on several prominent Midwestern railroads. This is another step in the modernization program being carried on by railroads to increase passenger traffic.

The new coolers are designed to overcome many disadvantages of the ice-cooled units. With foot operation of the self-contained units, only one hand need be used to get a drink. Cleanliness is promoted because of the absence of ice-filling operations, and the expense for maintenance and service is reduced to a minimum.

The water is automatically maintained at a healthful and refreshing temperature through thermostatic control. Coolers are designed either as self-contained units or as separate cooling and refrigerant condensing units for remote installations in the car.

96-363FBI

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A book which, a little over a year ago, offered a new opportunity in the presentation of production equipment from the engineer's viewpoint is now revised to keep it up-to-date. The revision is made possible by its wide and growing textbook use. Among the schools which have already adopted it are:

New York University
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